

***Estimated Radiological
Inventory Sent from the
Naval Reactors Facility to the
Subsurface Disposal Area from
1952 through 1999***

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**Idaho
Completion
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ABSTRACT

This supplemental report documents an update to the comprehensive inventory of radiological contaminants shipped from 1952 through 1999 from the Naval Reactors Facility of the Idaho National Engineering and Environmental Laboratory and then buried in the Subsurface Disposal Area at the Radioactive Waste Management Complex. This update involved reclassification of waste types and replacing projected inventories with actual inventory data or improved estimates provided as a result of detailed research efforts by Naval Reactors office personnel. These updated inventories have been compiled to support development of the Operable Unit -7-13/14 comprehensive remedial investigation and feasibility study under the Comprehensive Environmental Response, Compensation, and Liability Act.

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ACRONYMS

APAC	alkaline permanganate ammonium citrate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DOE-IBO	U.S. Department of Energy Idaho Branch Office
ECF	Expendable Core Facility
HDT	Historical Data Task
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology Engineering Center
LLW	low-level waste
LMITCO	Lockheed Martin Idaho Technologies Company
MELBA	Multipurpose Extended Life Blanket Assembly
NRF	Naval Reactors Facility
NRP	Naval Reactors Program
PA/CA	performance assessment/composite analysis
PWR	pressurized water reactor
RI/FS	remedial investigation/feasibility study
RPDT	Recent and Projected Data Task
SDA	Subsurface Disposal Area
SOAP	Special Oxide Assembly Prototype
TRA	Test Reactor Area
TRU	transuranic
TSA	Transuranic Storage Area

Estimated Radiological Inventory Sent from the Naval Reactors Facility to the Subsurface Disposal Area from 1952 through 1999

1. INTRODUCTION

This report provides updated radionuclide inventory estimates for waste sent by the U.S. Department of Energy (DOE) Naval Reactors Program (NRP) to the Idaho National Engineering and Environmental Laboratory (INEEL) for permanent landfill disposal at the Subsurface Disposal Area (SDA). The SDA occupies a portion of the Radioactive Waste Management Complex (RWMC), and is being assessed in a remedial investigation/feasibility study (RI/FS) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.). The SDA also contains an active low-level waste (LLW) landfill subject to performance assessment/composite analysis (PA/CA) in accordance with DOE Order 435.1, “Radioactive Waste Management.” The RI/FS and the PA/CA fall within the purview of the U.S. Department of Energy Idaho Operations Office (DOE-Idaho), whereas operations at the Naval Reactors Facility (NRF) are managed by the U.S. Department of Energy, Pittsburgh Naval Reactors Office Idaho Branch Operations (DOE-IBO).

Collectively, the buried waste is referred to as the source term. Parameters that describe characteristics of the source term, such as inventory estimates, are used to simulate release and migration of contaminants from buried waste. Therefore, the radionuclide inventory for the SDA is a critical element for the Operable Unit (OU) -7-13/14 RI/FS. Previous source term inventory estimates contained gaps resulting primarily from modifications to reporting requirements for waste disposal over time. This report supplements previously published inventory reports: two documents published in 1995, and one document published in 2001:

- *A Comprehensive Inventory of Radiological and Nonradiological Contaminants in Waste Buried in the Subsurface Disposal Area of the INEL RWMC During the Years 1952–1983* (LMITCO 1995a), which is commonly known and referred to hereafter in this document as the Historical Data Task (HDT). The HDT encompasses disposal of mixed waste, which was allowed until 1983, the end of the HDT timeframe. Disposal of transuranic (TRU) waste, which was permissible through 1970, also is included in the HDT timeframe.
- *A Comprehensive Inventory of Radiological and Nonradiological Contaminants in Waste Buried or Projected to be Buried in the Subsurface Disposal Area of the INEL RWMC During the Years 1984–2003* (LMITCO 1995b), which is commonly known and referred to hereafter in this document as the Recent and Projected Data Task (RPDT). The RPDT encompasses actual disposal inventories for 1984 through 1993 and projected inventories for 1994 through 2003. Only low-level waste disposals have been permissible in the SDA after 1983.
- *A Comprehensive Inventory of Radiological and Nonradiological Contaminants in Waste Buried or Projected to be Buried in the Subsurface Disposal Area of the INEEL RWMC during the Years of 1984 to 2003 Supplemental (Volume 1 of 2)* (Little et al. 2001), referred to as the RPDT Supplement. The RPDT Supplement replaced the projected inventories for 1994 through 1999 with actual inventories.

1.1 Purpose

The purpose for this report is to provide reasonably complete NRF inventory estimates for the OU -7-13/14 RI/FS under CERCLA and for updates to the PA/CA (Shuman 2000). For CERCLA, the validity of the source term inventory is fundamental for developing baseline risk assessments, identifying appropriate remedial alternatives, and supporting credible evaluation of remedial alternatives (e.g., containment; in situ treatment; and retrieval, ex situ treatment, and disposal). For the PA/CA, the inventory provides the basis for defining waste acceptance criteria and maintaining authorization for the current LLW disposal operation in the SDA under DOE Order 435.1.

1.2 Scope

This report relies heavily on information provided by DOE-IBO and their contract staff at NRF. Historical disposal inventories were reconstructed in close collaboration with NRF personnel using information about waste-generating processes, including reactor characteristics and operating histories. This report describes the assessment of NRF disposal histories and documents revised estimates of radioactive contaminants dispositioned from the NRF to the SDA during the period 1952 through 1997. Inventory data from 1998 and 1999 are summarized from Little et al. (2001) for completeness. Analysis focuses on radionuclides of concern to OU -7-13/14 (Holdren and Broomfield 2004) and the PA/CA. Additional radionuclides used to evaluate fate and transport models and uncertainty also are addressed. The radionuclides addressed in this report are as follows: Am-241, C-14, Cl-36, Co-60, Cs-137, H-3, I-129, Nb-94, Ni-59, Ni-63, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99, U-233, U-234, U-235, U-236, and U-238. Activation products, fission products, and actinides (i.e., uranium and TRU elements) are included.

1.3 Document Organization

Brief descriptions of the following sections of this report are given below:

- **Section 2**—provides a brief history and description of the SDA and a summary history and description of NRF and waste generating processes
- **Section 3**—documents the methods and results of the updated radionuclide waste inventory estimates for NRF for the period 1952 to 1983
- **Section 4**—documents the methods and results of updated radionuclide waste inventory estimates for NRF for the period 1984 through 1999
- **Section 5**—summarizes the inventory assessment analysis
- **Section 6**—lists the references cited throughout this report
- **Appendix A**—contains a yearly inventory breakdown of NRF shipments during the HDT (LMITCO 1995a) period from 1952 to 1983
- **Appendix B**—contains a yearly inventory breakdown of NRF shipments during the RPDT (LMITCO 1995b) period from 1984 to 1999
- **Appendix C**—contains copies of correspondence from DOE-IBO providing detailed information used to develop best-estimate and upper-bound estimates for each radionuclide addressed in this report.

2. BACKGROUND

The INEEL is a DOE facility located 52 km (32 mi) west of Idaho Falls, Idaho and occupies 2,305 km² (890 mi²) of the northeastern portion of the Eastern Snake River Plain (Figure 1). Locations of the SDA and NRF at the INEEL also are shown on Figure 1. Subsections that follow briefly describe the background of these two facilities.

2.1 Brief History and Description of the Subsurface Disposal Area

Located in the southwestern quadrant of the INEEL, the RWMC comprises 72 ha (177 acres) subdivided into three separate areas by function: the SDA, the Transuranic Storage Area (TSA), and the administration and operations area. The SDA is a radioactive waste landfill. Contaminants in the landfill include hazardous chemicals, remote-handled fission and activation products, and transuranic radionuclides. A map of the RWMC is shown in Figure 2. The original landfill, established in 1952, was called the National Reactor Testing Station Burial Ground. Now part of the SDA, the original landfill covered 5.2 ha (13 acres) and was used for shallow-land disposal of solid radioactive waste. In 1958, the disposal area was expanded to 35.6 ha (88 acres). Relocating the security fence in 1988 outside the dike surrounding the landfill established the SDA's current size as 39 ha (97 acres). The TSA was added to the RWMC in 1970. Located directly east of the SDA, the TSA's 23 ha (58 acres) is used to store, prepare, and ship retrievable TRU waste to the Waste Isolation Pilot Plant in Carlsbad, New Mexico. The 9-ha (22-acre) administration and operations area at the RWMC includes administrative offices, maintenance buildings, equipment storage, and miscellaneous support facilities.

2.2 History and Description of Naval Reactors Facility and Associated Waste Generating Processes

The NRF is located in the western part of INEEL about 194 km (14 mi) northeast of the RWMC (Figure 1). NRF was established at INEEL in 1950 and began shipping waste to the RWMC for burial in the SDA in 1952. During most of the period from 1952 to 1997, the facility included the following four principal operating installations, each of which sent radioactive waste to the SDA:

- S1W prototype plant (prototype for the USS Nautilus)
- A1W prototype plant (prototype for the USS Enterprise)
- S5G prototype plant (prototype for the USS Narwhal)
- Expended Core Facility (ECF).

Waste-generating processes and contaminant inventories associated with NRF operations have been previously documented in the HDT, RPDT, and RPDT Supplement (LMITCO 1995a and 1995b; Little et al. 2001). Waste was generated by prototype reactor operations and by ECF fuel examination work, and included dissolved and solid fuel, core structural materials, zirconium chips, liquids, oil, and alkaline permanganate ammonium citrate (APAC). Additionally, routine operations at the prototype reactors, ECF water pits, hot cells, and laboratories produced general plant waste, which included low-level compactable and noncompactable wastes. Contaminant inventory estimates presented in Sections 3 and 4 focus primarily on waste generated by NRF as a result of operations at prototype propulsion plants and the ECF. Chronologies of primary waste-generating processes are summarized in the sections that follow.

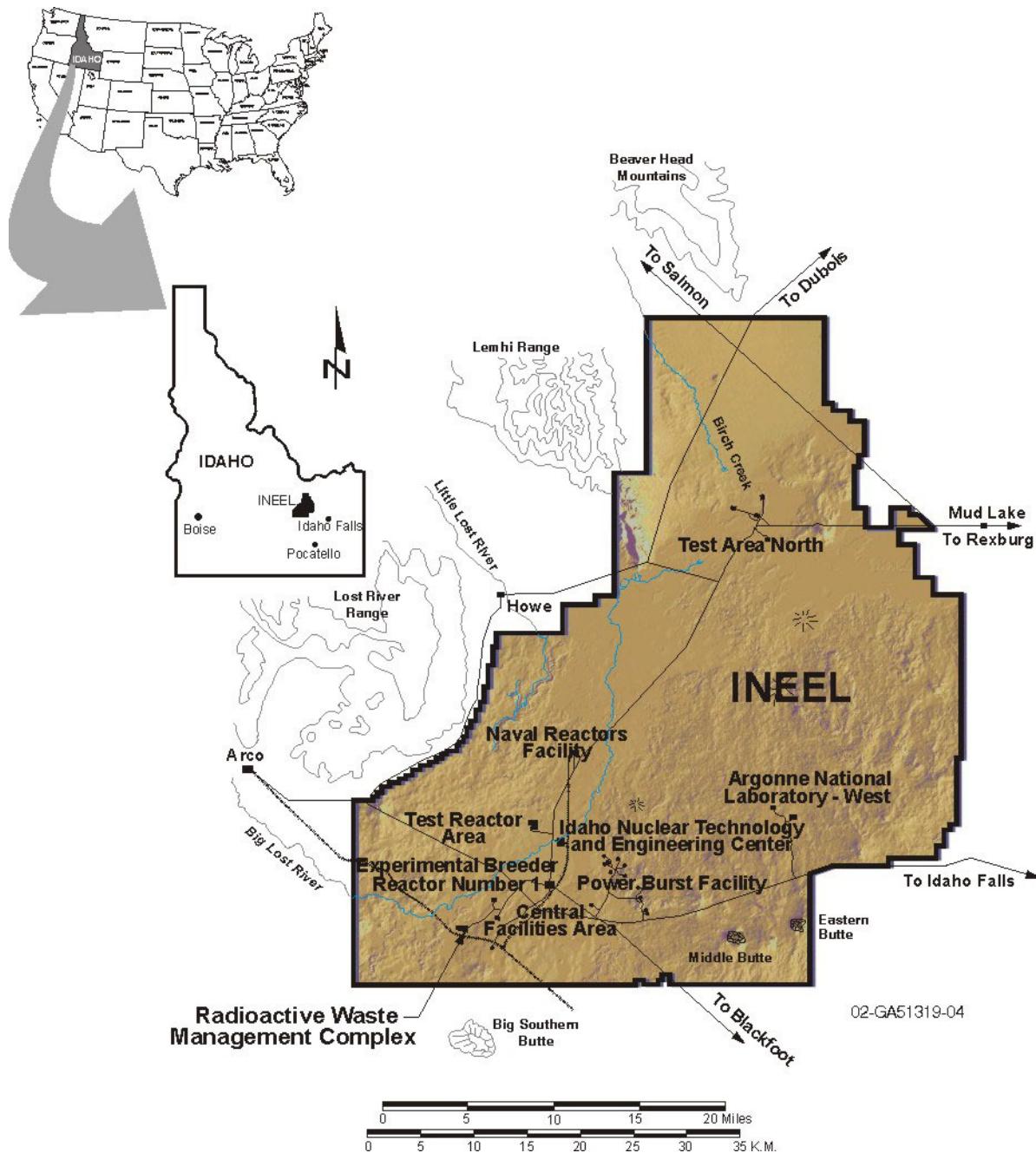


Figure 1. Map of the Idaho National Engineering and Environmental Laboratory showing the location of the Radioactive Waste Management Complex, the Naval Reactors Facility, and other major facilities.

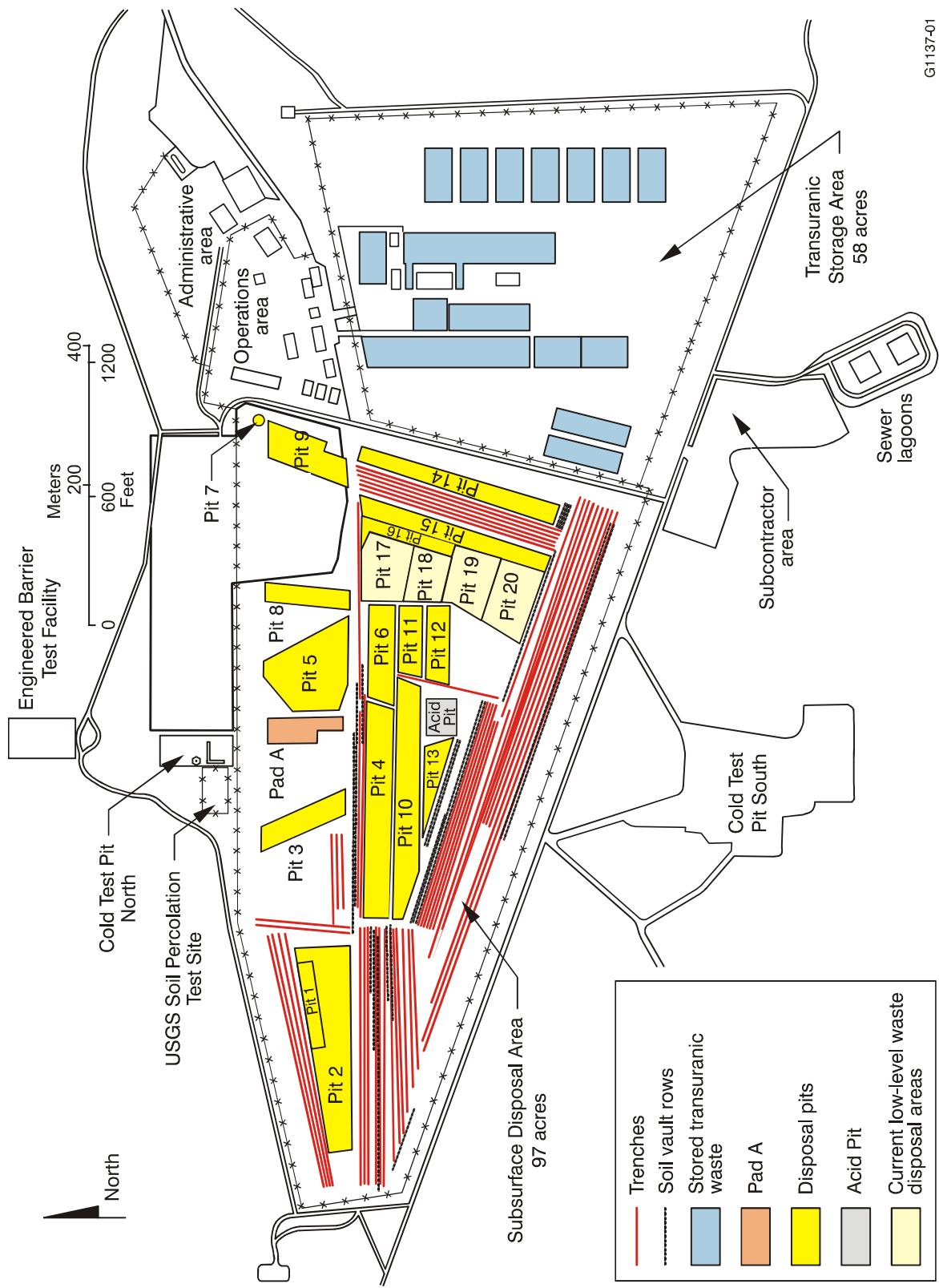


Figure 2. Map of the Radioactive Waste Management Complex.

2.2.1 Prototype Propulsion Plants

The functions of the three prototype reactor installations, the S1W, A1W, and S5G, included developing prototype reactors for NRP nuclear propulsion plants, proof testing a series of new core designs, and providing facilities for training naval personnel to operate such reactors. These three facilities each operated for 30 or more years and then were permanently shut down during the period from 1989 to 1995. Additional information regarding the chronology of events at these three prototype propulsion plants is provided below.

2.2.1.1 S1W Prototype Plant. Construction of the prototype reactor for the U.S. Navy's first nuclear submarine, the *USS Nautilus*, began at NRF in 1950. Power operations commenced in March 1953, with full design power achieved in June 1953. This prototype, identified as S1W, was developed to test propulsion plant design and to train Navy personnel to operate reactors. The S1W prototype was operated for 36 years, and used to train more than 12,500 Navy and civilian personnel. The S1W was permanently shut down in 1989. Additional information about the chronology of the plant operation is provided below.

- The first refueling occurred from September 1955 to March 1956. The first core was removed, including nonfuel-bearing core structurals, and replaced with the second core, which was the prototype for the *USS Seawolf* (SSN 575).
- The second refueling occurred from November 1957 to March 1958. The second core was removed, including nonfuel-bearing core structurals, and replaced with the third core (approximately 35 MW), which was a prototype for the *USS Skate* (SSN 578).
- The third refueling occurred from August 1960 through December 1960. The third core was removed, including nonfuel-bearing core structurals, and replaced with the fourth core (approximately 35 MW), which was a prototype for the *USS Swordfish* (SSN 579).
- The fourth refueling occurred from March 1965 to October 1967. The fourth core was removed, including all nonfuel-bearing core structurals. Primary coolant systems were decontaminated with APAC and the reactor vessel was extensively modified. The fifth core, (approximately 75 MW) installed and designed to demonstrate the feasibility of long-lived reactor cores, was a prototype core for the *USS Scamp* (SSN 588).
- The S1W plant was permanently shut down on October 17, 1989, after 22 years operation on the fifth core. Defueling was completed in May 1990.

2.2.1.2 A1W Prototype Plant. The first nuclear-powered surface ship prototype reactor, A1W, was designed and built for the aircraft carrier *USS Enterprise* (CVN 65), and the two initial cores were prototypes for eight cores that powered the ship. Construction began in 1956. The facility comprised two pressurized water reactors and the associated control areas designed to simulate the *Enterprise*. The A1W prototype plant comprised the "3A" and "3B" PWR plants, each approximately 175 MW. The A1W likely was fueled by a highly enriched uranium and zirconium alloy. Operation of the 3A and the 3B PWR plants commenced in October 1958 and July 1959, respectively. Both were operational until January 1994.

Operation of the A1W 3A plant commenced with the initial core in October 1958. Additional information about the subsequent chronology of the plant operation is provided below.

- The first refueling occurred from May 1963 to November 1964. The initial core was replaced and operation commenced with the second core on April 4, 1966.
- The second refueling was completed and operation with the third core commenced June 1972.
- The third refueling occurred September 1980 and operation commenced with the fourth core.

Operation of the A1W 3B plant commenced with the initial core in September 1959. Additional information about the subsequent chronology of the plant is provided below.

- The first refueling occurred from May 1963 to November 1964. The initial core was replaced, and operation commenced with the second core in November 1964.
- The second refueling occurred from April 1970 to July 1971. The second core was replaced, and operation commenced with the third core in July 1971.
- The third refueling occurred from June 1972 to May 1973. The third core was replaced, and operation commenced with the fourth core in May 1973. The fourth core was the prototype for a two-reactor aircraft carrier.
- Final plant shutdown occurred in January 1994, and defueling was completed in July 1997.

2.2.1.3 S5G Prototype Plant. Construction of the first natural circulation submarine prototype plant, S5G, was completed, and criticality achieved in 1965. The S5G was a prototype for the submarine *USS Narwhal* (SSN 671) and could operate in either forced or natural circulation modes. The S5G prototype was used to train approximately 12,000 Navy and civilian personnel over a 30-year period until it was shut down in 1995.

- The first refueling was completed, and operation commenced with the second core July 1986
- The plant was permanently shut down in May 1995, and defueling was completed in August 1997.

2.2.2 Expended Core Facility

The ECF was constructed in 1957 as a 340-ft-long building designed to receive irradiated Navy reactor fuel, remove excess core structural material from the fuel elements, examine the fuel elements, and prepare and transfer the fuel elements for shipment to the Idaho Nuclear Technology Engineering Center (INTEC). Fuel elements and complete reactor cores were received and processed at the ECF; through a sophisticated and delicate process, the material was transferred to pools of water, termed “water pits,” for detailed examination. The ECF inspected and analyzed fuels from S1W, A1W, and S5G in addition to fuel from the *USS Nautilus*, *USS Seawolf*, and other vessels. As new business came to NRF, the ECF was expanded to its present size of 305 m by 59 m (1,000 ft by 194 ft). In addition to fuel from the Navy, NRF specimens were irradiated at the Test Reactor Area (TRA) and returned to ECF. Spent fuel from the Shippingport pressurized water reactor (the Nation’s first commercial nuclear power reactor) also was shipped to the ECF for examination.

Nuclear fuel from approximately 130 submarines, four surface cruisers, and one aircraft carrier was handled at ECF. Taking refueling into account, between 300 and 350 ship reactor cores passed through the ECF during the past four decades.

Typically, structural end pieces were separated from the fuel underwater in a water pit. Fuel was transferred to INTEC while the end pieces were disposed of at the SDA. Disassembled end pieces contain a significant fraction of the activation products sent to the SDA from NRF.

Shipping records also show the presence of other significant irradiated core internals that were not necessarily metallic end pieces. In the process of end-piece separation, metallic fines (i.e., particles of metal) were released into the ECF water pits. In some cases, accidental cutting into the fuel in spent fuel assemblies released fission products and actinides into the ECF water pits. Trace amounts of fission products and actinides also were released into the water by surface uranium and fuel defects. Additionally, corrosion of material stored in the water pits at ECF released activation products into the pits.

Resins, sludge, and filters originating from the ECF hot cells also are significant waste streams. The contaminated waste streams were subsequently sent to the SDA.

Early shipping records (i.e., primarily before 1970) indicate that a number of miscellaneous ECF fuel scrap waste shipments were sent to the SDA. Most of these miscellaneous shipments involved chemically dissolved fuel that was absorbed in vermiculite. However, all of these shipments involved relatively small amounts (i.e., less than 500 g) of fuel scrap. Other fuel scrap waste streams related to TRA and Shippingport are discussed separately below.

2.2.2.1 Materials Testing. An aggressive fuel-testing program was begun in 1960 at TRA in conjunction with other NRF activities. Irradiated fuel from TRA was sent to specialized ECF hot cells for examination. Navy fuel was tested at TRA in the Materials Test Reactor, the Engineering Test Reactor, and more recently in the Advanced Test Reactor (ATR). The Materials Test Reactor and Engineering Test Reactor have been shut down. However, NRP fuel testing continues at ATR. Several pre-1970 shipping records show that some of the irradiated fuel scrap waste sent from TRA to ECF was subsequently discharged to the SDA.

2.2.2.2 Shippingport Reactor Fuel. In parallel with other early NRF programs, fuel from the world's first sizable nuclear electric power generator, the Shippingport Atomic Power Station, was sent to ECF for examination.

The Shippingport Atomic Power Station was the Nation's first commercial nuclear power reactor, with initial operation commencing in December 1957. Shippingport was a pressurized water reactor (PWR) initially rated at 225 MW (thermal). The Shippingport reactor's first core was a seed-and-blanket design fueled by enriched uranium. The seed assemblies consisted of highly enriched uranium-zirconium alloy plate fuel, and the blanket assemblies were composed of natural uranium. The first core (PWR-1) had three partial refuelings where the expended seed fuel was removed and replaced with new seed fuel. Selected blanket fuel also was removed and replaced during seed refueling. Final defueling of PWR-1 included removal of all seed and blanket fuel. The second core (PWR-2) included one refueling, where seed fuel was removed and replaced. Defueling included removal of all seed and blanket fuel in preparation for the light water breeder reactor (Appendix C, Section C-3).

Other test assemblies including the Special Oxide Assembly Prototype (SOAP I and II) and the Multipurpose Extended Life Blanket Assembly (MELBA), tested with cores PWR-1 and PWR-2, respectively, were irradiated during the Shippingport reactor operation.

All Shippingport PWR-1 and PWR-2 seed fuel, highly enriched uranium SOAP test assemblies, and a portion of the blanket fuel assemblies from PWR-1 were shipped to the ECF. Approximately one-third (4,330 kg) of the PWR-1 blanket fuel was shipped to ECF for examination, while the remaining

8,520 kg of blanket fuel were sent directly to Hanford for reprocessing (Appendix C, Section C-3). All seed fuel and SOAP assemblies were transferred to INTEC for processing. Based on disposal records and nuclear accountability information, approximately 214 kg of Shippingport blanket fuel (solid and dissolved) was shipped to the SDA for disposal. Section 3 of this report details, with respect to the Shippingport fuel, the radionuclide curies and grams disposed at the SDA.

All shipments of MELBA and PWR-2 seed and blanket fuel to the ECF occurred after 1970 and were not disposed of in the SDA. All PWR-2 fuel (including MELBA) that was not sent to INTEC for reprocessing, or offsite for testing, remains in storage at ECF (Appendix C, Section C-3).

3. ESTIMATED RADIOLOGICAL INVENTORIES FOR 1952 THROUGH 1983

The waste inventory compiled for the HDT timeframe of 1952 through 1983 (LMITCO 1995a) were revised to include new information and to develop more detailed waste characterization required for the OU -7-13/14 comprehensive RI/FS. The primary goal of revising the original radiological inventory estimates was to more thoroughly evaluate and characterize waste disposals related to:

- General plant waste, fuel scrap material, and process wastes from the prototype power plants
- Fuel scrap waste from the Shippingport reactor
- Miscellaneous ECF waste streams such as activated metal end pieces, resins, sludge, and fuel scrap waste generated by hot cell examination of Navy fuel test specimens irradiated at TRA.

3.1 Revised Waste Disposal Streams

The original waste stream descriptions in the HDT for NRF were changed from identifying waste by the process or reactor that generated it to identifying waste streams by similar type of material. These modified waste stream descriptions more accurately reflect waste types and inventories. Modified waste stream codes and descriptions for 1952 through 1983, the HDT timeframe, are discussed below. Table 1 maps the original HDT waste stream codes and descriptions to the modified waste stream codes.

Waste Stream NRF-MOD-1H (Shippingport fuel, solid, 1960-1968)

In the 1960s, prior to restrictions on curie content of fission and activation products and actinides, NRF disposed of a small amount of radioactive waste at the SDA containing Shippingport PWR Core 1 irradiated fuel. This waste stream includes both natural and enriched uranium. Most of this waste was in solid form, consisting of individual rods or bundles of rods. Of the 214 kg total of uranium in irradiated PWR fuel, complete fuel bundles were disposed of containing 190 kg of uranium, and individual rods or partial fuel bundles were disposed of containing 18 kg of uranium. The balance of the inventory was dissolved fuel, as discussed below.

Waste Stream NRF-MOD-2H (Shippingport fuel, dissolved, 1960-1968)

Approximately 3% of the total 214 kg of Shippingport fuel sent to the SDA was dissolved and absorbed in vermiculite. The fuel was dissolved in concentrated nitric and hydrofluoric acids for testing and analyses conducted at ECF. This waste contains both enriched and natural uranium.

Waste Stream NRF-MOD-3H (Miscellaneous enriched fuel, solid, 1960-1968)

Portions of Navy fuel underwent nondestructive testing and measurements at the ECF. Most of this fuel was then sent to INTEC for reprocessing; however, some of the fuel was sent from the ECF to the SDA for disposal.

Waste Stream NRF-MOD-4H (Miscellaneous enriched fuel, dissolved, 1953-1970)

This waste stream was generated at the ECF by destructive examination of portions of irradiated fuel elements from Navy cores and fuel materials tested at the TRA. The fuel specimens were typically dissolved using a combination of hydrofluoric and nitric acids. Liquid waste from this destructive testing was highly radioactive and absorbed in vermiculite for stabilization and disposal.

Waste Stream NRF-MOD-5H (Miscellaneous natural fuel, solid, 1953-1970)

In addition to the natural uranium fuel associated with the Shippingport fuel (NRF-MOD-1H and NRF-MOD-2H), a one-time disposal of 4.845 kg of U-238 associated with natural fuel that was irradiated in one of the prototype plants was disposed of in 1968. An additional shipment of unirradiated natural uranium fuel from an undisclosed source was also disposed of at the SDA (Appendix C, Section C-4).

Waste Stream NRF-MOD-6H (Core structural materials, 1953-1983)

Prior to shipment of irradiated fuel to INTEC, structural material was cut from the cores. This scrap material consisted primarily of irradiated stainless steel with some inconel and zircaloy. The scrap material was highly radioactive due to the large quantity of activation products in the metals. This material was remote-handled and shipped to the SDA in shielded scrap casks (LMITCO 1995a).

Waste Stream NRF-MOD-7H (Zirconium chips from ECF operations, 1953-1975)

This waste stream was generated from the process of disassembling reactor cores received at the ECF. Core structural material was cut from the reactor cores prior to sending the fuel elements for further examination or reprocessing at INTEC. The zirconium chips were generated during the cutting and milling operations on the fuel elements in the ECF water pits. The maximum size of the chips was $2 \times 187 \times 250$ mm. The materials were collected from the bottom of the ECF water pits and placed into 5-gal cans, which in turn were placed into a scrap cask insert and transported to the SDA.

Waste Stream NRF-MOD-8H (Liquid, APAC, and oil from ECF and prototype plant operations, 1953-1971)

Routine operations at ECF and the prototype power plants generated contaminated liquid and oil. Additionally, APAC decontamination solution was used during operations. The contaminants in this stream were associated with radioactive crud from plant systems and Navy cores from ECF operations; as such, a generic crud profile was used to estimate radionuclide activities in the waste at the time of disposal. The liquid waste was disposed of as free liquid or mixed with diatomaceous earth to form slurry-type material.

Waste Stream NRF-MOD-9H (Sludge and resins from ECF and prototype plant operations, 1953-1971)

Water purification systems were used at the ECF and prototype power plants to remove contaminants from storage pools and process water. Waste from these water purification systems included filters, resins, and resin-like materials, which were shipped to the SDA for disposal. Sludge or “crud” was also typically associated with the water systems. Two major sources contributed to this waste stream:

1. The ECF storage pool water (2 to 3 million gal) was purified with celite clarity filters. These filters became unserviceable in 1974 and were replaced with fiberglass resin tanks encased in concrete

vaults. Additionally, sludge collected in the bottoms of the ECF water pits and the storage pools and was periodically cleaned out, placed in 5-gal buckets, and transferred to the SDA.

2. Primary coolant resins from the prototype power plants were disposed of every 5 to 8 years. This resin material was contained in shielded carbon steel or stainless steel tanks.

Waste Stream NRF-MOD-10H (General plant waste – Compactable and noncompactable waste from ECF and prototype plant operations, 1952-1983)

Routine operations at the ECF and the three prototype power plants generated significant quantities of waste. Waste was generated at the ECF during receipt and shipment of reactor core and test materials, and during fuel examination. Routine operation and maintenance of the ECF also contributed to general plant waste. Waste was generated by the operation of the prototype power plants by reactor coolant sampling, maintenance and repair, and refueling. These operations required contact with contaminated plant internals, and the waste is primarily compactable (e.g., plastic bags, gloves, shoe covers, blotter paper, and other materials used to contain contamination). In addition to the compactable waste, metal valves, piping sections, or other contaminated objects may have been disposed of with the general plant waste. Most general plant waste would be classified as low-level waste.

Table 1. Original and revised descriptions for Naval Reactors Program waste streams buried in the Subsurface Disposal Area from 1952 to 1983.

Original Waste Stream Descriptions ^a		Revised Waste Stream Descriptions ^b	
Waste Stream Number	Description of Waste	Revised Waste Stream Number	Description of Waste
Not specifically identified in HDT		NRF-MOD-1H	Shippingport fuel, solid (1960-1968)
NRF-618-1H	Dissolved pressurized water reactor (PWR) irradiated fuel absorbed in vermiculite	NRF-MOD-2H	Shippingport fuel, dissolved (1960-1968)
Not specifically identified in HDT		NRF-MOD-3H	Miscellaneous enriched fuel, solid (1953-1970)
Not specifically identified in HDT		NRF-MOD-4H	Miscellaneous enriched fuel, dissolved (1953-1970)
Not specifically identified in HDT		NRF-MOD-5H	Miscellaneous natural fuel, solid (1953-1970)
NRF-618-2H	Structural components from Navy core fuel bundles; end boxes, and other components (1955-1975)	NRF-MOD-6H	Core structural materials (1953-1983)
NRF-618-3H	Structural components from Navy core fuel bundles; end boxes, and other components (1976-1980)		
NRF-618-4H	Structural components from Navy core fuel bundles; end boxes and other components (1981-1983)		
NRF-618-5H	Zircaloy cladding from Navy cores (1955-1975)	NRF-MOD-7H	Zirconium chips from ECF operations (1953-1975)
NRF-618-6H	Solidified sludge, resin, and waste liquids in vermiculite	NRF-MOD-8H	Liquid, APAC ^c , and oil from ECF and prototype plant operations (1953-1971)
NRF-618-6H	Solidified sludge, resin, and waste liquids in vermiculite	NRF-MOD-9H	Sludge and resins from ECF and prototype plant operations (1953-1971)

Table 1. (continued).

NRF-601-1H	Low-level compactable and noncompactable waste from operation of S1W reactor and related activities	NRF-MOD-10H	General plant waste – Compactable and noncompactable waste from ECF and prototype plant operations (1952-1983)
NRF-617-1H	Low-level compactable and noncompactable waste resulting from operation of A1W reactors		
NRF-617-2H	Lead and asbestos		
NRF-618-7H	Low-level compactable and noncompactable waste from work at ECF water pits and hot cells		
NRF-633-1H	Low-level compactable and noncompactable waste resulting from operation of the S5G reactor		

a. Original waste streams defined as part of the Historical Data Task (LMITCO 1993a).

b. Revised waste streams defined in NR:IBO-04/045 (Appendix C, Section C-2).

c. Alkaline permanganate ammonium citrate (APAC) decontamination solution.

3.2 Data Collection

Summary radionuclide inventory data presented in this report, comprising inventory totals by nuclide and waste stream, were provided by DOE-IBO for waste streams NRF-MOD-1H through NRF-MOD-9H in four DOE-IBO letters. These letters are provided in Appendix C, Sections C-1, C-2, C-3, and C-4. Inventory estimates for waste stream NRF-MOD-10H were developed in consultation with DOE-IBO and their contract staff using the method discussed below.

Information provided by DOE-IBO is the result of extensive research and calculations. This information was provided early to DOE-ID to support meeting enforceable milestones under the FFA/CO for OU -7-13/14. A final DOE-IBO report that documents their efforts will be published in 2005. Because of the close collaboration between DOE-ID, DOE-IBO, and respective contract staff, significant differences between the final DOE-IBO report and the estimates developed in this report are not anticipated. However, if significant differences are identified, DOE-ID will qualitatively evaluate their relevance to the baseline risk assessment and analysis of alternatives to be included in the OU -7-13/14 RI/FS.

3.2.1 Methodology for Estimating General Plant Waste Inventory

Because General Plant Waste (NRF-MOD-10H) was not addressed by DOE-IBO (see Appendix C, Section C-2), radionuclide activities for this waste stream were estimated in consultation with DOE-IBO and contract staff. This methodology included the following elements:

- Best-estimate activities for Co-60 ($1.21\text{E+}05$ Ci) and Ni-63 ($1.93\text{E+}04$ Ci) were taken from the HDT (LMITCO 1995a).
- Except for C-14, the remaining radionuclides were scaled from the total Co-60 activity ($1.21\text{E+}05$ Ci). Carbon-14 was excluded from the General Plant Waste profile because all C-14 activity was included in other waste streams.
- Scaling factors were calculated based on the isotopic distribution, normalized to Co-60, of the liquid waste profile (Liquid, APAC, oil from ECF and prototype plant operations) contained in Appendix C, Section C-2.

3.2.2 Methodology for Mapping Radionuclide Inventory

Radionuclide distributions in the SDA were mapped using total radionuclide inventories provided by DOE-IBO and sorted by nuclide and waste stream. The radionuclide inventories were subdivided and distributed to provide a disposal history by year. Radionuclide activities were assigned to individual shipments using the following five-step methodology:

1. Waste shipments were segregated into chronological order and grouping by year, followed by a line-by-line review of the descriptive information for all NRF shipments in the database, and assignment of waste classifications 1 through 10 (NRF-MOD-1H through NRF-MOD-10H), as listed in Table 1. In the absence of information suggestive of the waste classification, the shipment was assigned waste classification 10, General Plant Waste.
2. Best-estimate and upper-bound radionuclide activities were assigned to each individual shipment. Except for General Plant Waste and the two waste streams associated with the Shippingport fuel, estimates were obtained by multiplying the reported total activity for a given radionuclide in a

given waste stream (provided in Appendix C, Section C-2) by the ratio of the total curies reported on the shipping form to the total curies reported for all NRF shipments.

3. Shippingport Fuel (solid and dissolved, NRF-MOD-1H and NRF-MOD-2H, respectively) was distributed. Accountability records for the Shippingport fuel (see Appendix C, Section C-3) provide a total uranium mass shipped to the SDA and list individual shipments and their associated uranium masses. The percentage of uranium in each shipment was calculated from this information, and the weight-based percentage was then used to scale the individual radionuclide activities for each shipment from the totals provided in Appendix C, Sections C-1 and C-2.
4. General Plant Waste was estimated. Because General Plant Waste (waste stream 10) was not addressed in Appendix C (Section C2), radionuclide activities for this waste stream were estimated in consultation with Bechtel Bettis as described above in Section 3.2.1.
5. Activities were assigned to disposal forms that did not record radioactivity for the shipment. No information on total activities was available for most shipments in the 1954 to 1956 interval and several shipments (less than 50) in the 1957 to 1983 interval. In these instances, one of two approaches was applied to assign inventories:
 - a. A similar shipment was identified by professional judgment and used as a basis for scaling by weight, volume, exposure rate, or other relevant characteristic.
 - b. If a similar shipment could not be identified, the shipment was assigned 1 Ci of activity. Less than 10 shipments were arbitrarily assigned 1 Ci. The potential impact on totals was evaluated by first assigning a value of 0 Ci and then repeating the same calculation using a value of 1 Ci. The impact to the totals was less than 0.01% between the extremes of using zero and 1 Ci. However, failure to identify locations in the SDA with high concentrations of radioactivity could result from this approach.

Resulting radionuclide activities were summed for each radionuclide and for each year in the time interval of 1952 to 1983. Summary totals were checked by comparing calculated total activities to total activities provided in the references (Appendix C, Section C-2). These summary totals per radionuclide per year will be used in RI/FS and PA/CA modeling for the SDA.

Best-estimate inventory summaries are provided in subsequent sections for fission products, activation products, and actinides, respectively. For waste streams NRF-MOD-1H through NRF-MOD-9H, totals exactly match those provided by DOE-IBO. For waste stream NRF-MOD-10H, it is expected that the final DOE-IBO inventory report will include the same totals as those presented herein (Appendix C, Section C-1).

3.3 Estimated Fission Product Inventory

Fission products are produced in fuel elements as a result of the fission process induced by thermal neutrons, or as the fuel is “burned” inside the reactor cores. The fission products addressed in this report include Cs-137, I-129, Sr-90, and Tc-99. Fuel associated with NRF disposals at the SDA came from the Shippingport PWR-1 core and miscellaneous test specimens received at the ECF from Navy propulsion power plants, from the prototype power plants at NRF and irradiation test program at TRA. As a result, fission product inventory is primarily associated with the irradiated fuel material disposed in the SDA from waste streams NRF-MOD-1H (Shippingport Fuel, solid), NRF-MOD-2H (Shippingport Fuel, dissolved), NRF-MOD-3H (Miscellaneous Enriched Fuel, solid), NRF-MOD-4H (Miscellaneous Fuel, dissolved), and NRF-MOD-5H (Miscellaneous Natural Fuel). Fission product inventories were estimated

from calculated or measured burnup of irradiated fuels. In the case of the Shippingport fuel, the fission product inventory was estimated using the Oak Ridge Generation and Depletion code (ORIGEN) (Appendix C, Section C-3; Croff 1980). After the preliminary Shippingport Fuel review was provided in Appendix C, Section C-3, records were identified indicating that the small amount of the blanket fuel disposed at the SDA came from locations that were more irradiated than average. As a result, the fission product best estimate curie content provided in the preliminary Shippingport Fuel Review was increased by 50%, and the upper bound estimates are an additional 50% greater than the best estimates (see Appendix C, Section C-2).

Fission products also are associated, to a significantly lesser extent, with the other waste streams (Table 1) because of contamination from routine processes and operations at the ECF and prototype power plants. Estimates of fission products for the remaining five waste streams (i.e., NRF-MOD-6H through NRF-MOD-10H) were typically scaled from reported Co-60 activities based on a generic NRF crud or liquid waste profile (Appendix C, Section C-4). Cesium-137 and Sr-90 activities for waste stream NRF-MOD-6H were obtained by taking the ratios of these nuclides to Nb-94 (activation product) in a more recent evaluation of core structural materials. These ratios were then scaled using the Nb-94 reported activity from Appendix C (Section C-7) to obtain the Cs-137 and Sr-90 activities, and other fission product radionuclide activities for the core structural waste stream (Appendix C, Section C-2). The values provided by this method for waste stream NRF-MOD-6H are upper-bound estimates because assay of three pieces of structural waste showed that actual values are lower (Appendix C, Sections C-2 and C-4). Best estimates were taken at 50% of the upper-bound estimates.

Best estimates for fission products disposed of at the SDA by NRF are provided in Table 2. Upper-bound estimates are provided in Appendix A. Uncertainties associated with the fission product inventory estimates are discussed in Section 3.6.

Table 2. Best estimate fission product inventory (C_i) by waste stream for 1952 through 1983.

Radionuclide	NRF-MOD -IH (C_i)	NRF-MOD -2H (C_i)	NRF-MOD -3H (C_i)	NRF-MOD -4H (C_i)	NRF-MOD -5H (C_i)	NRF-MOD -6H (C_i)	NRF-MOD -7H (C_i)	NRF-MOD -8H (C_i)	NRF-MOD -9H (C_i)	NRF-MOD -10H (C_i)
Cs-137	1.06E+04	2.80E+02	2.07E+02	1.33E+02	2.46E+02	7.09E+00	4.49E-01	2.03E-01	1.02E+00	4.78E+01
I-129	3.90E-03	1.06E-04	4.94E-05	3.16E-05	9.06E-05	3.82E-05	1.73E-07	2.03E-05	1.01E-04	4.78E-03
Sr-90	6.24E+03	1.65E+02	2.06E+02	1.32E+02	1.45E+02	3.74E+00	2.72E-01	2.03E-01	1.02E+00	4.78E+01
Tc-99	1.49E+00	3.93E-02	2.85E-02	1.83E-02	3.46E-02	2.03E-02	9.02E-05	5.05E-03	2.56E-02	1.19E+00

3.4 Estimated Activation Product Inventory

Activation products are generated through absorption of thermal neutrons by stable elements, primarily those in corrosion resistant metals used in core structural components (e.g., stainless steel, inconel, and zircaloy). Activation products addressed in this report include C-14, Cl-36, Co-60, H-3, Nb-94, Ni-59 and Ni-63. The activation product inventory associated with NRF waste disposals at the SDA during the HDT period is primarily present in waste streams NRF-MOD-6H (core structural), NRF-MOD-7H (zirconium chips), NRF-MOD-8H (liquid, APAC, and oil), NRF-MOD-9H (sludge and resin), and NRF-MOD-10H (general plant waste).

Activation product inventories reported before 1990 included primarily Co-60 activities. However, shipments of core structural material waste (NRF-MOD-6H) and zirconium chips (NRF-MOD-7H) contained trace amounts of other activation products. Revised estimates for these waste streams are based on the concentrations of precursor (i.e., stable) elements identified in the materials through actual testing, vendor certifications, and literature resources. Neutron fluence values used in the activation calculations are best-estimate values; thus, the overall calculations produced best-estimate radionuclide inventories (Appendix C, Section C-7). Estimates for NRF-MOD-6H were further refined through extensive research by Navy personnel. In 2001, NRF contracted with Argonne National Laboratory to measure activation products in three samples of activated core structural components. The calculated activity exceeded the measured activity in these three samples by factors of 3, 7, and 40, thus demonstrating the conservativeness of the NRF estimates (Bradley 2002). Estimates for NRF-MOD-7H were based on the concentrations of precursor elements in the 6,146 kg (13,550 lb) of zirconium chip waste sent to the SDA for disposal.

Activation products associated with the NRF-MOD-8H (liquid, APAC, and oil), NRF-MOD-9H (sludge and resin), and the NRF-MOD-10H (general plant waste) shipments were estimated from a generic crud profile developed by NRF personnel (Appendix C, Section C-4) using an assumed radionuclide composition. The highest radiation readings identified in the shipping records associated with these waste streams were then used to estimate the activities of the radionuclides present in the waste at the time of disposal (Appendix C, Section C-4).

Best-estimate inventories for activation products are presented in Table 3. Appendix A provides a summary by year, of the best estimates and upper-bound estimates. The uncertainties associated with these estimates are presented in Section 3.6.

Table 3. Best estimate activation product inventory (C_i) by waste stream for 1952 through 1983.

Radionuclide	NRF-MOD- $^{1\text{H}}$ (C_i)	NRF-MOD $^{-2\text{H}}$ (C_i)	NRF-MOD $^{-3\text{H}}$ (C_i)	NRF-MOD $^{-4\text{H}}$ (C_i)	NRF-MOD $^{-5\text{H}}$ (C_i)	NRF-MOD $^{-6\text{H}}$ (C_i)	NRF-MOD $^{-7\text{H}}$ (C_i)	NRF-MOD $^{-8\text{H}}$ (C_i)	NRF-MOD $^{-9\text{H}}$ (C_i)	NRF-MOD $^{-10\text{H}}$ (C_i)
C-14	2.84E-02	7.49E-04	2.36E-07	1.51E-07	6.60E-04	3.82E+01	3.28E+00	4.05E+00	1.65E+01	-
Cl-36	-	-	-	-	-	1.58E-01	4.95E-03	-	-	-
Co-60	-	-	-	-	-	4.75E+05	-	5.05E+02	2.54E+03	1.19E+05
H-3	4.62E+01	1.22E+00	8.17E-01	5.23E-01	1.07E+00	1.09E+02	6.70E+00	-	-	-
Nb-94	1.37E-05	3.62E-07	8.59E-08	5.50E-08	3.19E-07	5.06E+00	2.74E-03	1.02E-01	5.10E-01	2.40E+01
Ni-59	-	-	-	-	-	1.17E+03	3.93E-02	1.52E+00	7.65E+00	3.58E+02
Ni-63	-	-	-	-	-	1.32E+05	4.97E+00	1.52E+02	7.65E+02	1.90E+04

3.5 Estimated Actinide Inventory

The actinide inventory at the SDA from NRF disposals is primarily associated with natural and enriched nuclear reactor fuel. These fuels contained actinides before the fuels were placed in the reactor core. During reactor operation, additional actinides are produced through a combination of transmutation and decay processes. Actinides associated with NRF waste disposals at the SDA include Am-241, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, U-233, U-234, U-235, U-236, and U-238. The primary waste streams associated with actinide waste include NRF-MOD-1H (Shippingport Fuel, solid), NRF-MOD-2H (Shippingport Fuel, dissolved), NRF-MOD-3H (Miscellaneous Enriched Fuel, solid), NRF-MOD-4H (Miscellaneous Fuel, dissolved), and NRF-MOD-5H (Miscellaneous Natural Fuel, solid). These waste streams were sent to the SDA for disposal primarily during the years 1953 through 1970, with one additional test-specimen disposal in 1973.

Results of an extensive review of fuel shipping records pertaining to the Shippingport reactor are presented in Appendix C (Section C-4). This review indicated that 214 kg of irradiated natural uranium associated with the Shippingport PWR-1 core were disposed of at the SDA. The radionuclide content of the irradiated Shippingport fuel was estimated using ORIGEN-S calculations. These calculations produced estimates of isotopic plutonium activities that were three times higher than radiochemical assays of fuel samples conducted in the 1960s. As such, the ORIGEN-S calculations are identified as upper-bound estimates for plutonium isotopes. The best estimates are taken as one third of the upper-bound estimates to account for the ORIGEN-S overcalculation (see Section 3.3), plus 50% to account for the additional irradiation (Appendix C, Sections C-2 and C-4). An additional shipment of unirradiated natural uranium fuel from an undisclosed source was also disposed of at the SDA. The actinide inventory from this unburned fuel was added to waste stream NRF-MOD-1H (Appendix C, Sections C-2 and C-4).

In addition to the natural uranium fuel associated with the Shippingport fuel (NRF-MOD-1H and NRF-MOD-2H), a one-time disposal of 4.845 kg of U-238 associated with natural fuel that was irradiated in a Navy core in one of the prototype plants was disposed of in 1968. The curie content of this material was estimated by scaling from the Shippingport fuel. Subsequent reviews of waste disposal records and fuel accountability and transfer records found evidence that only very small quantities of nuclear material containing enriched uranium were sent by NRF to the SDA for disposal. Based on these records, it is estimated that 205 g of enriched uranium (i.e., fuel specimens from test reactors) was sent from NRF operations to the SDA. Of the 205 g of enriched uranium, approximately 80 g was associated with more mobile waste streams such as dissolved fuel or ion exchangers, and the remaining 125 g was associated with solid fuel material (Appendix C, Section C-4).

Actinides associated with nonfuel waste streams from NRF were estimated from generic crud profiles for NRF-MOD-8H (liquid, APAC, and oil) and NRF-MOD-9H (sludge and resin) waste streams (Appendix C, Section C-2 and C-4). Actinides associated with the core structural waste stream were obtained by taking the ratios of these nuclides to Nb-94 (activation product) in an evaluation of core structural materials. These ratios were then scaled using the Nb-94 reported activity from Appendix C (Section C-7) to obtain the actinide activities for the core structural waste stream (Appendix C, Sections C-2 and C-4). The values provided by this method for waste stream NRF-MOD-6H are upper-bound estimates because assay of three pieces of structural waste showed that actual values are lower (Appendix C, Sections C-1 and C-4). Best estimates for the actinides were taken at 50% of the upper-bound estimates.

Best estimates for actinides disposed of at the SDA are provided in Table 4. Upper-bound estimates are provided in Appendix A. Uncertainties associated with actinide inventory estimates are discussed in Section 3.6.

Table 4. Best estimate actinide inventory (Ci) by waste stream for 1952 through 1983.

Radionuclide	NRF-MOD -1H (Ci)	NRF-MOD -2H (Ci)	NRF-MOD -3H (Ci)	NRF-MOD -4H (Ci)	NRF-MOD -5H (Ci)	NRF-MOD -6H (Ci)	NRF-MOD -7H (Ci)	NRF-MOD -8H (Ci)	NRF-MOD -9H (Ci)	NRF-MOD -10H (Ci)
Am-241	1.08E+01	2.85E-01	2.38E-03	1.52E-03	2.51E-01	1.09E-01	1.78E-03	1.78E-03	8.95E-03	4.19E-01
Np-237	2.66E-03	7.03E-05	9.70E-04	6.20E-04	6.19E-05	-	1.16E-06	1.52E-08	7.65E-08	3.58E-06
Pu-238	1.18E+01	3.12E-01	3.75E+00	2.40E+00	2.75E-01	6.93E-02	2.37E-03	1.27E-03	6.40E-03	2.99E-01
Pu-239	4.43E+01	1.17E+00	7.74E-03	4.96E-03	1.03E+00	1.64E-01	1.35E-02	2.03E-04	1.02E-03	4.78E-02
Pu-240	3.86E+01	1.02E+00	2.23E-03	1.42E-03	8.98E-01	1.01E-01	4.72E-03	1.27E-04	6.40E-04	2.99E-02
Pu-241	3.03E+03	8.01E+01	1.14E+00	7.30E-01	7.05E+01	8.57E+00	3.13E-01	5.05E-02	2.55E-01	1.18E+01
U-233	1.44E-06	3.80E-08	4.27E-07	2.73E-07	3.35E-08	-	8.79E-05	1.37E-06	6.90E-06	3.23E-04
U-234	6.95E-02	1.53E-03	7.01E-03	4.49E-03	1.35E-03	1.09E-04	7.87E-06	1.52E-06	7.70E-06	3.58E-04
U-235	1.47E-03	2.49E-05	8.60E-05	5.50E-05	2.20E-05	3.12E-06	2.00E-07	1.07E-10	5.35E-10	2.52E-08
U-236	1.00E-02	2.65E-04	8.78E-04	5.62E-04	2.33E-04	1.01E-05	6.08E-07	5.60E-09	2.81E-08	1.32E-06
U-238	7.97E-02	1.81E-03	3.75E-07	2.40E-07	1.59E-03	1.17E-04	7.07E-06	2.49E-08	1.25E-07	5.86E-06

3.6 Uncertainties

Methods used to estimate and distribute comprehensive inventories of fission products, activation products, and actinides consist of a combination of deterministic and empirical techniques. These methods were supplemented by assumptions to address bounding conditions such as the masses of irradiated materials, material compositions, and neutron fluence rates. These supplemental assumptions were defined to produce reasonable best-estimate and upper-bound inventory estimates.

The major elements that contribute to the overall uncertainty in the contaminant inventories are:

1. Irradiation histories and radiation spectrums of a particular waste stream
2. Materials composition for a particular waste stream
3. The total mass for particular waste stream
4. Uncertainties due to computer code calculations or calculations that used scaling factors
5. Interpretations of shipping records to correlate waste streams with the disposal manifest of a specific shipment, and the potential for undocumented burials or disposals of materials.

Concerning items 1 through 3, waste stream activity estimates are typically based on a combination of direct radiation assays and indirect methods that estimate activities from known radiation measurements. Disposal records generally contain only exposure rate measurements (i.e., mR/hr), and the associated uncertainties are high. The magnitudes of these measurements are a function of a particular waste shipment, and in many cases, important beta- and alpha- emitters were typically shielded and not accounted for. Without supplemental knowledge such as irradiation or burnup histories of a particular shipment along with its materials composition and mass, precise inventory estimates cannot be developed. This supplemental information was generally limited for NRF disposals. Computational uncertainties (Item 4) are caused by cross-section uncertainties, decay times, numerical solution of the differential equations, uncertainties in input data, and other factors.

Concerning item 4, radionuclide buildup simulations usually require two or more coupled computational algorithms to simulate nuclide transmutations. In general, a neutron transport computer code is coupled to a nuclide transmutation code. The transport code calculates neutron fluxes to provide input to the transmutation code, which then calculates the buildup of various nuclides such as Co-60 and Pu-239. In the case of NRF activity estimates, burnup histories and neutron fluxes were developed as discussed below. The corresponding nuclide buildup calculations were performed with the ORIGEN-2 code (Coff 1980). An alternate approach using measured waste stream gamma fields and scaling factors also was used.

Concerning item 5, assumptions about waste streams were formulated to ensure that the buried waste activity inventories were bounded. Gross radiation fields for gamma-emitters such as Co-60 can be correlated to other undetected nuclides like Tc-99 via the use of empirical correlations that scale to other nuclides. However, these methods have significant attendant uncertainties if the irradiation history of the measured waste stream or the material composition is unknown.

Because of the highly variable and shipment-dependent nature of many of the waste streams, standard statistical uncertainty methods were not feasible to define individual uncertainty factors. As in the original HDT report (LMITCO 1995a), methodology for defining the best-estimate activities and associated upper and lower bounds was based on professional (e.g., engineering) judgment and other

reasonable assumptions because data were not available to support rigorous statistical error propagation modeling.

Uncertainties associated with radionuclide activities presented in this report were derived on a waste stream basis, and are discussed in detail in Appendix C.

4. ESTIMATED RADIOLOGICAL INVENTORIES FOR 1984 THROUGH 1999

The same approach described in Section 3 for the HDT timeframe with only minor differences was applied to develop revised inventory estimates for the RPDT timeframe. Elements specific to the RPDT period from 1984 through 1999 are described herein. Estimates for 1984 through 1997 are based on information supplied by DOE-IBO, while data for 1998 and 1999 are taken from the RPDT Supplement (Little et al. 2001). The RPDT Supplement developed estimates for 1994 through 1999; information supplied by NRF is replacing estimates in the RPDT Supplement for 1994 through 1997 and data from the RPDT Supplement for 1998 and 1999 are being duplicated here for completeness. Other differences from the HDT timeframe are described in sections that follow.

4.1 Revised Disposal Waste Streams

Waste generated at NRF during the RPDT timeframe for disposal at the SDA consisted of process wastes from prototype power plants and ECF. The original waste stream descriptions in the RPDT for NRF were changed from identifying waste by the process or reactor that generated it to identifying waste streams by similar type of material. These modified waste stream descriptions more accurately reflect waste types and inventories. Modified waste stream codes and descriptions for 1984 through 1999, the RPDT timeframe, are discussed below. Table 5 maps the original RPDT waste stream codes and descriptions to the modified waste stream codes.

Waste Stream NRF-MOD-6R (Core structural materials, 1984-1997)

Waste Stream NRF-MOD-6S (Core structural materials, 1998-1999)

Before shipment of irradiated fuel to INTEC, structural material was cut from the cores at the ECF. This scrap material consisted primarily of irradiated stainless steel with some inconel and zircaloy. The scrap material was highly radioactive due to the large quantity of activation products in the metals. This material was remote-handled, and shipped to the SDA in shielded scrap casks (LMITCO 1995b).

Waste Stream NRF-MOD-10R (General plant waste – Compactable and noncompactable waste from ECF and prototype plant operations, 1984-1997)

Waste Stream NRF-MOD-10S (General plant waste – Compactable and noncompactable waste from ECF and prototype plant operations, 1998-1999)

Routine operations at the ECF and the three prototype power plants generated significant quantities of waste. Waste was generated at the ECF by fuel examination, and receipt and shipment of core materials and test materials. Routine operation and maintenance of the ECF also contributed to general plant waste. Waste was generated by the operation of the prototype power plants by reactor coolant sampling, maintenance and repair, and refueling. These operations required contact with contaminated plant internals, and the waste is primarily compactable (e.g., plastic bags, gloves, shoe covers, blotter paper, and other materials used to contain contamination). In addition to the compactable waste, metal valves, piping sections, or other contaminated objects may have been disposed of with the general plant waste. Most general plant waste would be classified as low-level waste.

Table 5. Original and revised descriptions for Naval Reactors Program waste streams buried in the Subsurface Disposal Area from 1984 to 1999.

Waste Stream Number	Original Waste Stream Descriptions ^a		Revised Waste Stream Descriptions ^b	
	Description of Waste	Waste Stream Number	Description of Waste	Waste Stream Descriptions ^b
NRF-618-4R	Structural components removed from NRP nuclear fuel modules (e.g., end boxes) 1984 to 1988 (LMITCO 1995b)	NRF-MOD-6R	Core structural materials (1984-1997)	
NRF-618-8R	Structural components removed from NRP nuclear fuel modules (e.g., end boxes, etc.) 1989 to 1993 (LMITCO 1995b)	NRF-MOD-6S	Core structural materials (1998-1999)	
NRF-618-8	Structural components removed from U.S. Navy nuclear fuel modules 1994 to 1999 (Little et al. 2001)			
NRF-601-2	Contaminated soil, gravel, brick, and concrete rubble from the deactivation, decontamination, and decommissioning of the S1W evaporation pond (Little et al. 2001)	NRF-MOD-10R	General plant waste – Compactable and noncompactable waste from ECF and prototype plant operations (1984-1997)	
NRF-617-1R	Low-level compactable and noncompactable waste resulting from operation of the prototype reactors and related activities from 1984 to 1993 (LMITCO 1995b)	NRF-MOD-10S	General plant waste – Compactable and noncompactable waste from ECF and prototype plant operations (1998-1999)	
NRF-617-2R	Lead and asbestos 1984 to 1993 (LMITCO 1995b)			
NRF-618-6R	Solidified sludge, resin, waste liquids in vermiculite, Radioactive Waste Disposal System waste 1984 to 1993 (LMITCO 1995b)			
NRF-618-6	Resin and resin containers removed from the Naval Reactors Facility prototypes (Little et al. 2001)			
NRF-618-7R	Low-level compactable waste resulting from work at the ECF water pits and hot cells 1984 to 1993 (LMITCO 1995b)			
	Low-level compactable and noncompactable			

Table 5. (continued).

Original Waste Stream Descriptions ^a		Revised Waste Stream Descriptions ^b	
Waste Stream Number	Description of Waste	Waste Stream Number	Description of Waste
NRF-618-7	waste resulting from work at the prototypes, the ECF water pits, and the ECF hot cells (Little et al. 2001)		
NRF-618-9	Concrete and concrete residue generated from decommissioning ECF hot cells and prototypes. Concrete and metal surfaces contain polychlorinated biphenyl in the form of dried paint (Little et al. 2001)		
NRF-618-AA	One-time waste stream of contaminated, radioactive oil solidified in Petrosel (Little et al. 2001)		

a. Original waste streams defined as part of the Recent and Projected Data Task (LMITCO 1995b, Little et al. 2001)).
 b. Revised waste streams defined in NR:IBO-04/045 (Appendix C, Section C-2).

4.2 Data Collection

The same methodologies described in Section 3.2 for the HDT timeframe was applied to develop revised estimates and map those estimates to waste shipments for the RPDT timeframe. Best-estimate inventory summaries are provided in subsequent sections for fission products, activation products, and actinides, respectively. For waste stream NRF-MOD-6R from 1984 through 1997, totals exactly match those provided by DOE-IBO. For waste stream NRF-MOD-10R, it is expected that the final DOE-IBO inventory report will include the same totals as those presented here. Totals for NRF-MOD-6S and NRF-MOD-10S match those for 1998 and 1999 in the RPDT Supplement (Little et al. 2001).

4.3 Estimated Fission Product Inventory

Fission products are produced in fuel elements as a result of the fission process induced by thermal neutrons, or as the fuel is “burned” inside the reactor cores. The fission products addressed in this report include Cs-137, I-129, Sr-90, and Tc-99.

Fission product inventories in NRF waste for the period 1984 through 1999 are associated with Core Structural Materials and General Plant Waste from routine processes and operations at the ECF and prototype power plants. Estimates of Cs-137 and Sr-90 activities for waste stream NRF-MOD-6R were obtained by taking the ratios of these nuclides to Nb-94 (activation product) in core structural materials. These ratios were then scaled using the Nb-94 reported activity from Appendix C (Section C-7) to obtain the Cs-137 and Sr-90 activities, and other fission product radionuclide activities for the core structural waste stream (Appendix C, Sections C-2 and C-4). The values provided by this method for waste stream NRF-MOD-6R are upper-bound estimates because assay of three pieces of structural waste showed that actual values are lower (Appendix C, Sections C-1 and C-4). Best estimates were taken as 50% of the upper-bound estimates. Methodology for estimating the fission product inventory for waste stream NRF-MOD-10R is described in Section 3.2.

Fission product inventories in NRF waste for the period 1998 through 1999 also are associated with Core Structural Materials and General Plant Waste from routine processes and operations at the ECF and prototype power plants. Estimates of fission product inventories for this period were obtained by subtracting the totals from the years 1994 through 1997 from the totals (1994 through 1999) provided in Little et al. (2001).

Best estimates for fission products disposed of at the SDA by NRF are provided in Table 6. Upper-bound estimates are provided in Appendix A. Uncertainties associated with inventory estimates are discussed in Section 3.6.

Table 6. Best-estimate fission product inventory (Ci) by waste stream for 1984 through 1999.

Radionuclide	NRF-MOD-6R (Ci)	NRF-MOD-10R (Ci)	NRF-MOD-6S (Ci)	NRF-MOD-10S (Ci)
Cs-137	2.01E+00	8.46E-01	4.43E-02	5.04E-02
I-129	1.08E-05	8.46E-05	3.89E-08	7.15E-07
Sr-90	1.06E+00	8.46E-01	5.85E-02	6.05E-02
Tc-99	5.74E-03	2.10E-02	4.97E-04	2.34E-04

4.4 Estimated Activation Product Inventory

Activation products are generated through absorption of thermal neutrons by stable elements, primarily those in corrosion resistant metals used in core structural components (e.g., stainless steel, inconel, and zircaloy). Activation products addressed in this report include C-14, Cl-36, Co-60, H-3, Nb-94, Ni-59 and Ni-63. The activation product inventory associated with NRF waste disposals at the SDA during the RPDT period (1984 through 1999) is primarily present in waste streams NRF-MOD-6R (core structural), and NRF-MOD-10R (general plant waste). The same methodology described in Section 3.4 for the HDT timeframe was applied for the RPDT interval from 1994 through 1997.

Activation product inventories in NRF waste for the period 1998 through 1999 also are associated with Core Structural Materials and General Plant Waste from routine processes and operations at the ECF and prototype power plants. Estimates of activation product inventories for this period were obtained by subtracting the totals for the years 1994 through 1997 from the totals for the years 1994 through 1999 provided in Little et al. (2001).

Best-estimate inventories for activation products are presented in Table 7. Appendix A provides a summary by year of the best estimates and upper-bound estimates. Uncertainties associated with these estimates are presented in Section 4.6.

Table 7. Best estimate activation product inventory (Ci) by waste stream for time period 1984 through 1999.

Radionuclide	NRF-MOD-6R (Ci)	NRF-MOD-10R (Ci)	NRF-MOD-6S (Ci)	NRF-MOD-10S (Ci)
C-14	1.08E+01	-	4.39E-01	1.31E-01
Cl-36	4.49E-02	-	8.23E-03	5.88E-05
Co-60	1.35E+05	2.10E+03	1.46E+03	1.04E+01
H-3	3.09E+01	-	2.68E+00	2.37E-02
Nb-94	1.44E+00	4.25E-01	1.32E-01	2.38E-02
Ni-59	3.31E+02	6.33E+00	2.22E+01	1.15E+00
Ni-63	3.76E+04	3.36E+02	2.67E+03	1.13E+02

4.5 Estimated Actinide Inventory

The actinide inventory at the SDA from NRF disposals primarily is associated with natural and enriched nuclear reactor fuel. These waste streams were sent to the SDA during the years 1953 through 1970, before disposal restrictions precluded landfill disposal of fuel. Only trace amounts of these contaminants were contained in nonfuel-bearing waste disposed of after 1970. Actinides associated with the NRF waste disposals at the SDA include Am-241, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, U-233, U-234, U-235, U-236, and U-238.

Actinide inventories associated with nonfuel waste streams from NRF were estimated by taking the ratios of these nuclides to Nb-94 (activation product) in core structural materials. These ratios were then scaled using the Nb-94 reported activity from Appendix C (Section C-7) to obtain the actinide activities for the core structural waste stream (Appendix C, Sections C-2 and C-4). The values provided by this method for waste stream NRF-MOD-6R are upper-bound estimates because assay of three pieces of

structural waste showed that actual values are lower (Appendix C, Sections C-2 and C-4). Best estimates for the actinides were taken at 50% of the upper-bound estimates. The methodology for estimating the actinide inventory for waste stream NRF-MOD-10R is described further in Section 4.2.

Actinide inventories in NRF waste for the period 1998 through 1999 also are associated with Core Structural Materials and General Plant Waste from routine processes and operations at the ECF and prototype power plants. Estimates of actinide inventories for this period were obtained by subtracting the totals for the years 1994 through 1997 from the totals for the years 1994 through 1999 provided in Little et al. (2001).

Best estimates for actinides disposed of at the SDA by NRF are provided in Table 8. Upper-bound estimates are provided in Appendix A. Uncertainties associated with the actinide inventory estimates are discussed in Section 4.6.

Table 8. Best estimate actinide inventory (Ci) by waste stream for time period 1984 through 1999.

Radionuclide	NRF-MOD-6R (Ci)	NRF-MOD-10R (Ci)	NRF-MOD-6S (Ci)	NRF-MOD-10S (Ci)
Am-241	3.09E-02	7.42E-03	-	8.50E-04
Np-237	-	6.33E-08	-	-
Pu-238	1.97E-02	5.29E-03	-	7.43E-04
Pu-239	4.64E-02	8.46E-04	-	1.13E-04
Pu-240	2.87E-02	5.29E-04	-	1.25E-04
Pu-241	2.43E+00	2.09E-01	5.36E-02	1.49E-02
U-233	-	5.71E-06	-	-
U-234	3.09E-05	6.33E-06	-	-
U-235	8.84E-07	4.46E-10	-	-
U-236	2.87E-06	2.33E-08	-	-
U-238	3.31E-05	1.04E-07	-	-

4.6 Uncertainties

The uncertainties associated with the radionuclide inventories for the period 1984 through 1997 are identical to those presented in Section 3.6 for the period 1952 through 1983. It should be noted that during this later period, waste disposal records were typically of higher quality (e.g., contained more complete information regarding waste content, and listed activities for more radionuclides). Uncertainties associated with the radionuclide activities presented in this report were derived on a waste stream basis, and are discussed in detail in Appendix C for the period 1984 through 1997, and in Little et al. (2001) for the years 1998 and 1999.

5. CONCLUSIONS AND RECOMMENDATIONS

This report documents the reassessment of NRF waste disposal shipments sent to the SDA during the HDT, RPDT, and RPDT Supplement periods from 1952 through 1999. Waste streams containing fission products, activation products, and actinides were reassessed in this report. Best estimates from the HDT, RPDT, and RPDT Supplement periods are presented in Table 9. The combined inventories shown in Table 5-1 are compiled from separate inventories presented in Sections 3 and 4.

This report presents best-estimate and upper-bound analysis of fission products, activation products, and actinides associated with NRF operations. Technically defensible estimates of radionuclide activities for individual waste shipments from NRF to the SDA were developed from detailed investigations and reviews of shipping and waste records, nuclear material accountability forms, and extensive deterministic calculations using known irradiation histories of these waste streams.

Table 9. Summary of NRF best estimate radionuclide inventory from 1952 through 1999.

Nuclide	Historical Data Task Best Estimate (1952 through 1983)	Recent and Projected		Total (1952 through 1999) (Ci)
		Data Task Best Estimate (1984 through 1997) (Ci)	Data Task Supplement Best Estimate (1998 through 1999) (Ci)	
Am-241	1.19E+01	3.84E-02	8.50E-04	1.19E+01
C-14	6.20E+01	1.08E+01	5.70E-01	7.34E+01
Cl-36	1.63E-01	4.49E-02	8.29E-03	2.16E-01
Co-60	5.97E+05	1.37E+05	1.47E+03	7.36E+05
Cs-137	1.15E+04	2.86E+00	9.47E-02	1.15E+04
H-3	1.66E+02	3.09E+01	2.70E+00	1.99E+02
I-129	9.12E-03	9.54E-05	7.54E-07	9.21E-03
Nb-94	2.97E+01	1.86E+00	1.56E-01	3.17E+01
Ni-59	1.54E+03	3.38E+02	2.33E+01	1.90E+03
Ni-63	1.52E+05	3.79E+04	2.78E+03	1.93E+05
Np-237	4.39E-03	6.33E-08	-	4.39E-03
Pu-238	1.89E+01	2.50E-02	7.43E-04	1.89E+01
Pu-239	4.67E+01	4.72E-02	1.13E-04	4.68E+01
Pu-240	4.07E+01	2.93E-02	1.25E-04	4.07E+01
Pu-241	3.20E+03	2.64E+00	6.85E-02	3.21E+03
Sr-90	6.94E+03	1.91E+00	1.19E-01	6.94E+03
Tc-99	2.85E+00	2.68E-02	7.31E-04	2.88E+00
U-233	4.21E-04	5.71E-06	-	4.27E-04
U-234	8.44E-02	3.73E-05	-	8.44E-02
U-235	1.66E-03	8.84E-07	-	1.66E-03
U-236	1.20E-02	2.90E-06	-	1.20E-02
U-238	8.32E-02	3.32E-05	-	8.33E-02

6. REFERENCES

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Appendix A

NRF Annual Inventory for HDT Time Period 1952 through 1983: Best Estimates and Upper-Bound Estimates

Table A-1. NRF-MOD-1H best estimate inventory summary (1962-1968).

	1962	1965	1967	1968	Total
Am-241	1.87E-01	8.25E-02	1.39E-01	1.04E+01	1.08E+01
C-14	4.91E-04	2.17E-04	3.66E-04	2.73E-02	2.84E-02
Cl-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	1.83E+02	8.10E+01	1.37E+02	1.02E+04	1.06E+04
H-3	7.99E-01	3.53E-01	5.95E-01	4.45E+01	4.62E+01
I-129	6.74E-05	2.98E-05	5.02E-05	3.75E-03	3.90E-03
Nb-94	2.37E-07	1.05E-07	1.76E-07	1.32E-05	1.37E-05
Ni-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-237	4.60E-05	2.03E-05	3.43E-05	2.56E-03	2.66E-03
Pu-238	2.04E-01	9.02E-02	1.52E-01	1.14E+01	1.18E+01
Pu-239	7.66E-01	3.39E-01	5.71E-01	4.26E+01	4.43E+01
Pu-240	6.67E-01	2.95E-01	4.97E-01	3.71E+01	3.86E+01
Pu-241	5.24E+01	2.32E+01	3.90E+01	2.92E+03	3.03E+03
Sr-90	1.08E+02	4.77E+01	8.04E+01	6.00E+03	6.24E+03
Tc-99	2.58E-02	1.14E-02	1.92E-02	1.43E+00	1.49E+00
U-233	2.49E-08	1.10E-08	1.85E-08	1.39E-06	1.44E-06
U-234	1.20E-03	5.31E-04	8.95E-04	6.69E-02	6.95E-02
U-235	2.54E-05	1.12E-05	1.89E-05	1.41E-03	1.47E-03
U-236	1.73E-04	7.64E-05	1.29E-04	9.62E-03	1.00E-02
U-238	1.38E-03	6.09E-04	1.03E-03	7.67E-02	7.97E-02

Table A-2. NRF-MOD-2H best estimate inventory summary (1960-1964).

	1960	1961	1962	1964	Total
Am-241	5.36E-02	6.47E-02	1.52E-01	1.49E-02	2.85E-01
C-14	1.41E-04	1.70E-04	3.99E-04	3.92E-05	7.49E-04
Cl-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	5.26E+01	6.35E+01	1.49E+02	1.47E+01	2.80E+02
H-3	2.29E-01	2.77E-01	6.50E-01	6.39E-02	1.22E+00
I-129	1.99E-05	2.41E-05	5.65E-05	5.55E-06	1.06E-04
Nb-94	6.81E-08	8.21E-08	1.93E-07	1.90E-08	3.62E-07
Ni-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-237	1.32E-05	1.60E-05	3.75E-05	3.68E-06	7.03E-05
Pu-238	5.87E-02	7.08E-02	1.66E-01	1.63E-02	3.12E-01
Pu-239	2.20E-01	2.65E-01	6.23E-01	6.13E-02	1.17E+00
Pu-240	1.92E-01	2.31E-01	5.43E-01	5.34E-02	1.02E+00
Pu-241	1.51E+01	1.82E+01	4.27E+01	4.19E+00	8.01E+01
Sr-90	3.10E+01	3.74E+01	8.79E+01	8.64E+00	1.65E+02
Tc-99	7.39E-03	8.92E-03	2.09E-02	2.06E-03	3.93E-02
U-233	7.14E-09	8.62E-09	2.02E-08	1.99E-09	3.80E-08
U-234	2.88E-04	3.47E-04	8.15E-04	8.01E-05	1.53E-03
U-235	4.68E-06	5.65E-06	1.33E-05	1.30E-06	2.49E-05
U-236	4.98E-05	6.01E-05	1.41E-04	1.39E-05	2.65E-04
U-238	3.40E-04	4.11E-04	9.64E-04	9.48E-05	1.81E-03

Table A-3. NRF-MOD-3H best estimate inventory summary (1955-1970).

	1955	1956	1957	1968	1969	1970	Total
Am-241	8.65E-08	8.65E-06	2.17E-03	4.33E-05	1.30E-04	3.00E-05	2.38E-03
C-14	8.58E-12	8.58E-10	2.15E-07	4.29E-09	1.29E-08	2.97E-09	2.36E-07
Cl-36	0.00E+00						
Co-60	0.00E+00						
Cs-137	7.53E-03	7.53E-01	1.89E+02	3.76E+00	1.13E+01	2.61E+00	2.07E+02
H-3	2.97E-05	2.97E-03	7.44E-01	1.49E-02	4.46E-02	1.03E-02	8.17E-01
I-129	1.80E-09	1.80E-07	4.50E-05	8.98E-07	2.69E-06	6.23E-07	4.94E-05
Nb-94	3.12E-12	3.12E-10	7.83E-08	1.56E-09	4.68E-09	1.08E-09	8.59E-08
Ni-59	0.00E+00						
Ni-63	0.00E+00						
Np-237	3.53E-08	3.53E-06	8.84E-04	1.76E-05	5.29E-05	1.22E-05	9.70E-04
Pu-238	1.36E-04	1.36E-02	3.42E+00	6.82E-02	2.05E-01	4.73E-02	3.75E+00
Pu-239	2.81E-07	2.81E-05	7.05E-03	1.41E-04	4.22E-04	9.76E-05	7.74E-03
Pu-240	8.11E-08	8.11E-06	2.03E-03	4.05E-05	1.22E-04	2.81E-05	2.23E-03
Pu-241	4.14E-05	4.14E-03	1.04E+00	2.07E-02	6.22E-02	1.44E-02	1.14E+00
Sr-90	7.49E-03	7.49E-01	1.88E+02	3.74E+00	1.12E+01	2.60E+00	2.06E+02
Tc-99	1.04E-06	1.04E-04	2.60E-02	5.18E-04	1.55E-03	3.59E-04	2.85E-02
U-233	1.55E-11	1.55E-09	3.89E-07	7.76E-09	2.33E-08	5.38E-09	4.27E-07
U-234	2.55E-07	2.55E-05	6.39E-03	1.27E-04	3.82E-04	8.84E-05	7.01E-03
U-235	3.13E-09	3.13E-07	7.83E-05	1.56E-06	4.69E-06	1.08E-06	8.60E-05
U-236	3.19E-08	3.19E-06	8.00E-04	1.60E-05	4.79E-05	1.11E-05	8.78E-04
U-238	1.36E-11	1.36E-09	3.42E-07	6.82E-09	2.05E-08	4.73E-09	3.75E-07

Table A-4. NRF-MOD-4H best estimate inventory summary
(1970-1973).

	1970	1973	Total
Am-241	3.10E-04	1.21E-03	1.52E-03
C-14	3.08E-08	1.20E-07	1.51E-07
Cl-36	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00
Cs-137	2.71E+01	1.06E+02	1.33E+02
H-3	1.07E-01	4.16E-01	5.23E-01
I-129	6.45E-06	2.52E-05	3.16E-05
Nb-94	1.12E-08	4.38E-08	5.50E-08
Ni-59	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00
Np-237	1.27E-04	4.93E-04	6.20E-04
Pu-238	4.90E-01	1.91E+00	2.40E+00
Pu-239	1.01E-03	3.95E-03	4.96E-03
Pu-240	2.90E-04	1.13E-03	1.42E-03
Pu-241	1.49E-01	5.81E-01	7.30E-01
Sr-90	2.69E+01	1.05E+02	1.32E+02
Tc-99	3.73E-03	1.46E-02	1.83E-02
U-233	5.57E-08	2.17E-07	2.73E-07
U-234	9.16E-04	3.57E-03	4.49E-03
U-235	1.12E-05	4.38E-05	5.50E-05
U-236	1.15E-04	4.47E-04	5.62E-04
U-238	4.90E-08	1.91E-07	2.40E-07

Table A-5. NRF-MOD-5H best estimate inventory summary
(1963-1970).

	1963	1970	Total
Am-241	2.51E-01	1.51E-04	2.51E-01
C-14	6.60E-04	3.96E-07	6.60E-04
Cl-36	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00
Cs-137	2.46E+02	1.48E-01	2.46E+02
H-3	1.07E+00	6.42E-04	1.07E+00
I-129	9.05E-05	5.43E-08	9.06E-05
Nb-94	3.19E-07	1.91E-10	3.19E-07
Ni-59	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00
Np-237	6.19E-05	3.71E-08	6.19E-05
Pu-238	2.75E-01	1.65E-04	2.75E-01
Pu-239	1.03E+00	6.18E-04	1.03E+00
Pu-240	8.97E-01	5.38E-04	8.98E-01
Pu-241	7.05E+01	4.23E-02	7.05E+01
Sr-90	1.45E+02	8.69E-02	1.45E+02
Tc-99	3.46E-02	2.07E-05	3.46E-02
U-233	3.35E-08	2.01E-11	3.35E-08
U-234	1.35E-03	8.10E-07	1.35E-03
U-235	2.20E-05	1.32E-08	2.20E-05
U-236	2.33E-04	1.40E-07	2.33E-04
U-238	1.59E-03	9.53E-07	1.59E-03

Table A-6. NRF-MOD-6H best estimate inventory summary (1954-1964).

	1954	1955	1956	1957	1958	1959	1960	1961	1963	1964
Am-241	1.03E-07	1.01E-04	1.14E-05	3.91E-06	8.09E-06	2.69E-04	4.85E-07	7.76E-07	4.43E-05	3.53E-04
C-14	3.61E-05	3.53E-02	3.99E-03	1.37E-03	2.83E-03	9.40E-02	1.70E-04	2.72E-04	1.55E-02	1.24E-01
Cl-36	1.50E-07	1.46E-04	1.65E-05	5.66E-06	1.17E-05	3.89E-04	7.04E-07	1.13E-06	6.42E-05	5.12E-04
Co-60	4.50E-01	4.40E+02	4.97E+01	1.70E+01	3.52E+01	1.17E+03	2.12E+00	3.38E+00	1.93E+02	1.54E+03
Cs-137	6.71E-06	6.56E-03	7.42E-04	2.54E-04	5.26E-04	1.75E-02	3.16E-05	5.05E-05	2.88E-03	2.30E-02
H-3	1.03E-04	1.01E-01	1.14E-02	3.91E-03	8.09E-03	2.69E-01	4.85E-04	7.76E-04	4.43E-02	3.53E-01
I-129	3.61E-11	3.53E-08	3.99E-09	1.37E-09	2.83E-09	9.40E-08	1.70E-10	2.72E-10	1.55E-08	1.24E-07
Nb-94	4.79E-06	4.69E-03	5.30E-04	1.81E-04	3.76E-04	1.25E-02	2.25E-05	3.61E-05	2.06E-03	1.64E-02
Ni-59	1.11E-03	1.08E+00	1.22E-01	4.19E-02	8.67E-02	2.88E+00	5.20E-03	8.32E-03	4.75E-01	3.78E+00
Ni-63	1.25E-01	1.23E+02	1.39E+01	4.74E+00	9.82E+00	3.26E+02	5.90E-01	9.43E-01	5.38E+01	4.29E+02
Np-237	0.00E+00									
Pu-238	6.57E-08	6.42E-05	7.25E-06	2.48E-06	5.14E-06	1.71E-04	3.09E-07	4.94E-07	2.82E-05	2.25E-04
Pu-239	1.55E-07	1.51E-04	1.71E-05	5.86E-06	1.21E-05	4.03E-04	7.28E-07	1.16E-06	6.64E-05	5.30E-04
Pu-240	9.59E-08	9.38E-05	1.06E-05	3.63E-06	7.51E-06	2.49E-04	4.51E-07	7.21E-07	4.11E-05	3.28E-04
Pu-241	8.11E-06	7.93E-03	8.97E-04	3.07E-04	6.36E-04	2.11E-02	3.81E-05	6.10E-05	3.48E-03	2.78E-02
Sr-90	3.54E-06	3.46E-03	3.91E-04	1.34E-04	2.77E-04	9.21E-03	1.66E-05	2.66E-05	1.52E-03	1.21E-02
Tc-99	1.92E-08	1.88E-05	2.12E-06	7.25E-07	1.50E-06	4.99E-05	9.02E-08	1.44E-07	8.23E-06	6.56E-05
U-233	0.00E+00									
U-234	1.03E-10	1.01E-07	1.14E-08	3.91E-09	8.09E-09	2.69E-07	4.85E-10	7.76E-10	4.43E-08	3.53E-07
U-235	2.95E-12	2.89E-09	3.26E-10	1.12E-10	2.31E-10	7.67E-09	1.39E-11	2.22E-11	1.27E-09	1.01E-08
U-236	9.59E-12	9.38E-09	1.06E-09	3.63E-10	7.51E-10	2.49E-08	4.51E-11	7.21E-11	4.11E-09	3.28E-08
U-238	1.11E-10	1.08E-07	1.22E-08	4.19E-09	8.67E-09	2.88E-07	5.20E-10	8.32E-10	4.75E-08	3.78E-07

Table A-6 (continued). NRF-MOD-6H best estimate inventory summary (1965-1974).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Am-241	9.55E-03	2.41E-02	2.47E-02	4.25E-03	2.42E-02	5.17E-03	2.51E-04	3.49E-04	2.58E-04	1.58E-04
C-14	3.34E+00	8.43E+00	8.64E+00	1.49E+00	8.48E+00	1.81E+00	8.78E-02	1.22E-01	9.02E-02	5.54E-02
Cl-36	1.39E-02	3.49E-02	3.58E-02	6.17E-03	3.51E-02	7.50E-03	3.64E-04	5.07E-04	3.74E-04	2.29E-04
Co-60	4.16E+04	1.05E+05	1.08E+05	1.85E+04	1.06E+05	2.25E+04	1.09E+03	1.52E+03	1.12E+03	6.90E+02
Cs-137	6.21E-01	1.57E+00	1.60E+00	2.76E-01	1.58E+00	3.36E-01	1.63E-02	2.27E-02	1.68E-02	1.03E-02
H-3	9.55E+00	2.41E+01	2.47E+01	4.25E+00	2.42E+01	5.17E+00	2.51E-01	3.49E-01	2.58E-01	1.58E-01
I-129	3.34E-06	8.43E-06	8.64E-06	1.49E-06	8.48E-06	1.81E-06	8.78E-08	1.22E-07	9.02E-08	5.54E-08
Nb-94	4.44E-01	1.12E+00	1.15E+00	1.97E-01	1.13E+00	2.40E-01	1.16E-02	1.62E-02	1.20E-02	7.35E-03
Ni-59	1.02E+02	2.58E+02	2.65E+02	4.56E+01	2.60E+02	5.54E+01	2.69E+00	3.74E+00	2.76E+00	1.70E+00
Ni-63	1.16E+04	2.93E+04	3.00E+04	5.16E+03	2.94E+04	6.28E+03	3.05E+02	4.24E+02	3.13E+02	1.92E+02
Np-237	0.00E+00									
Pu-238	6.07E-03	1.53E-02	1.57E-02	2.70E-03	1.54E-02	3.29E-03	1.59E-04	2.22E-04	1.64E-04	1.01E-04
Pu-239	1.43E-02	3.61E-02	3.70E-02	6.38E-03	3.64E-02	7.76E-03	3.76E-04	5.24E-04	3.87E-04	2.37E-04
Pu-240	8.87E-03	2.24E-02	2.29E-02	3.95E-03	2.25E-02	4.80E-03	2.33E-04	3.24E-04	2.39E-04	1.47E-04
Pu-241	7.51E-01	1.89E+00	1.94E+00	3.34E-01	1.90E+00	4.06E-01	1.97E-02	2.74E-02	2.03E-02	1.24E-02
Sr-90	3.28E-01	8.26E-01	8.46E-01	1.46E-01	8.31E-01	1.77E-01	8.60E-03	1.20E-02	8.84E-03	5.43E-03
Tc-99	1.77E-03	4.48E-03	4.58E-03	7.90E-04	4.50E-03	9.60E-04	4.66E-05	6.49E-05	4.79E-05	2.94E-05
U-233	0.00E+00									
U-234	9.55E-06	2.41E-05	2.47E-05	4.25E-06	2.42E-05	5.17E-06	2.51E-07	3.49E-07	2.58E-07	1.58E-07
U-235	2.73E-07	6.88E-07	7.05E-07	1.22E-07	6.92E-07	1.48E-07	7.17E-09	9.98E-09	7.37E-09	4.52E-09
U-236	8.87E-07	2.24E-06	2.29E-06	3.95E-07	2.25E-06	4.80E-07	2.33E-08	3.24E-08	2.39E-08	1.47E-08
U-238	1.02E-05	2.58E-05	2.65E-05	4.56E-06	2.60E-05	5.54E-06	2.69E-07	3.74E-07	2.76E-07	1.70E-07

Table A-6 (continued). NRF-MOD-6H best estimate inventory summary (1975-1983).

	1975	1976	1977	1978	1979	1980	1981	1982	1983	Total
Am-241	1.60E-04	2.38E-03	4.68E-03	1.14E-03	3.59E-03	1.27E-03	5.50E-04	2.29E-04	1.26E-03	1.09E-01
C-14	5.61E-02	8.34E-01	1.64E+00	3.97E-01	1.26E+00	4.44E-01	1.92E-01	8.01E-02	4.42E-01	3.82E+01
Cl-36	2.32E-04	3.45E-03	6.79E-03	1.65E-03	5.21E-03	1.84E-03	7.97E-04	3.32E-04	1.83E-03	1.58E-01
Co-60	6.98E+02	1.04E+04	2.04E+04	4.95E+03	1.57E+04	5.53E+03	2.40E+03	9.97E+02	5.50E+03	4.75E+05
Cs-137	1.04E-02	1.55E-01	3.04E-01	7.38E-02	2.34E-01	8.25E-02	3.57E-02	1.49E-02	8.21E-02	7.09E+00
H-3	1.60E-01	2.38E+00	4.68E+00	1.14E+00	3.59E+00	1.27E+00	5.50E-01	2.29E-01	1.26E+00	1.09E+02
I-129	5.61E-08	8.34E-07	1.64E-06	3.97E-07	1.26E-06	4.44E-07	1.92E-07	8.01E-08	4.42E-07	3.82E-05
Nb-94	7.44E-03	1.11E-01	2.17E-01	5.27E-02	1.67E-01	5.89E-02	2.55E-02	1.06E-02	5.86E-02	5.06E+00
Ni-59	1.72E+00	2.55E+01	5.02E+01	1.22E+01	3.85E+01	1.36E+01	5.89E+00	2.45E+00	1.35E+01	1.17E+03
Ni-63	1.94E+02	2.89E+03	5.69E+03	1.38E+03	4.36E+03	1.54E+03	6.68E+02	2.78E+02	1.53E+03	1.32E+05
Np-237	0.00E+00									
Pu-238	1.02E-04	1.51E-03	2.98E-03	7.22E-04	2.28E-03	8.07E-04	3.49E-04	1.45E-04	8.03E-04	6.93E-02
Pu-239	2.40E-04	3.57E-03	7.02E-03	1.70E-03	5.39E-03	1.90E-03	8.25E-04	3.43E-04	1.89E-03	1.64E-01
Pu-240	1.49E-04	2.21E-03	4.35E-03	1.05E-03	3.34E-03	1.18E-03	5.10E-04	2.12E-04	1.17E-03	1.01E-01
Pu-241	1.26E-02	1.87E-01	3.68E-01	8.92E-02	2.82E-01	9.97E-02	4.32E-02	1.80E-02	9.92E-02	8.57E+00
Sr-90	5.49E-03	8.17E-02	1.61E-01	3.89E-02	1.23E-01	4.35E-02	1.88E-02	7.84E-03	4.33E-02	3.74E+00
Tc-99	2.97E-05	4.42E-04	8.70E-04	2.11E-04	6.67E-04	2.36E-04	1.02E-04	4.25E-05	2.34E-04	2.03E-02
U-233	0.00E+00									
U-234	1.60E-07	2.38E-06	4.68E-06	1.14E-06	3.59E-06	1.27E-06	5.50E-07	2.29E-07	1.26E-06	1.09E-04
U-235	4.58E-09	6.81E-08	1.34E-07	3.24E-08	1.03E-07	3.62E-08	1.57E-08	6.54E-09	3.61E-08	3.12E-06
U-236	1.49E-08	2.21E-07	4.35E-07	1.05E-07	3.34E-07	1.18E-07	5.10E-08	2.12E-08	1.17E-07	1.01E-05
U-238	1.72E-07	2.55E-06	5.02E-06	1.22E-06	3.85E-06	1.36E-06	5.89E-07	2.45E-07	1.35E-06	1.17E-04

Table A-7. NRF-MOD-7H best estimate inventory summary (1955-1964).

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Am-241	1.77E-11	6.19E-06	1.86E-06	7.09E-07	1.24E-05	9.42E-06	7.44E-05	8.45E-05	2.25E-04	2.97E-05
C-14	3.27E-08	1.14E-02	3.43E-03	1.31E-03	2.28E-02	1.74E-02	1.37E-01	1.56E-01	4.15E-01	5.48E-02
Cl-36	4.93E-11	1.72E-05	5.18E-06	1.97E-06	3.45E-05	2.62E-05	2.07E-04	2.35E-04	6.26E-04	8.27E-05
Co-60	0.00E+00									
Cs-137	4.47E-09	1.56E-03	4.70E-04	1.79E-04	3.13E-03	2.38E-03	1.88E-02	2.13E-02	5.68E-02	7.50E-03
H-3	6.67E-08	2.33E-02	7.01E-03	2.67E-03	4.66E-02	3.55E-02	2.80E-01	3.18E-01	8.48E-01	1.12E-01
I-129	1.72E-15	6.01E-10	1.81E-10	6.89E-11	1.20E-09	9.15E-10	7.23E-09	8.21E-09	2.19E-08	2.89E-09
Nb-94	2.73E-11	9.53E-06	2.87E-06	1.09E-06	1.91E-05	1.45E-05	1.15E-04	1.30E-04	3.47E-04	4.58E-05
Ni-59	3.91E-10	1.37E-04	4.11E-05	1.57E-05	2.74E-04	2.08E-04	1.64E-03	1.87E-03	4.97E-03	6.56E-04
Ni-63	4.95E-08	1.73E-02	5.20E-03	1.98E-03	3.46E-02	2.63E-02	2.08E-01	2.36E-01	6.29E-01	8.30E-02
Np-237	1.15E-14	4.03E-09	1.21E-09	4.62E-10	8.08E-09	6.14E-09	4.85E-08	5.51E-08	1.47E-07	1.94E-08
Pu-238	2.36E-11	8.24E-06	2.48E-06	9.44E-07	1.65E-05	1.25E-05	9.91E-05	1.13E-04	3.00E-04	3.96E-05
Pu-239	1.34E-10	4.69E-05	1.41E-05	5.38E-06	9.40E-05	7.14E-05	5.64E-04	6.41E-04	1.71E-03	2.25E-04
Pu-240	4.70E-11	1.64E-05	4.94E-06	1.88E-06	3.29E-05	2.50E-05	1.97E-04	2.24E-04	5.97E-04	7.88E-05
Pu-241	3.12E-09	1.09E-03	3.28E-04	1.25E-04	2.18E-03	1.66E-03	1.31E-02	1.49E-02	3.96E-02	5.23E-03
Sr-90	2.71E-09	9.46E-04	2.85E-04	1.08E-04	1.89E-03	1.44E-03	1.14E-02	1.29E-02	3.44E-02	4.54E-03
Tc-99	8.98E-13	3.14E-07	9.44E-08	3.59E-08	6.28E-07	4.77E-07	3.77E-06	4.28E-06	1.14E-05	1.51E-06
U-233	8.75E-13	3.06E-07	9.20E-08	3.50E-08	6.12E-07	4.65E-07	3.68E-06	4.17E-06	1.11E-05	1.47E-06
U-234	7.84E-14	2.74E-08	8.24E-09	3.13E-09	5.48E-08	4.16E-08	3.29E-07	3.74E-07	9.96E-07	1.31E-07
U-235	1.99E-15	6.95E-10	2.09E-10	7.96E-11	1.39E-09	1.06E-09	8.36E-09	9.50E-09	2.53E-08	3.34E-09
U-236	6.05E-15	2.11E-09	6.36E-10	2.42E-10	4.23E-09	3.22E-09	2.54E-08	2.89E-08	7.69E-08	1.02E-08
U-238	7.04E-14	2.46E-08	7.40E-09	2.82E-09	4.92E-08	3.74E-08	2.96E-07	3.36E-07	8.95E-07	1.18E-07

Table A-7 (continued). NRF-MOD-7H best estimate inventory summary (1965-1975).

	1965	1966	1967	1968	1970	1971	1973	1974	1975	Total
Am-241	4.90E-04	2.42E-04	5.88E-06	1.77E-11	1.77E-04	4.19E-04	1.19E-06	1.20E-06	1.80E-07	1.78E-03
C-14	9.03E-01	4.45E-01	1.08E-02	3.27E-08	3.26E-01	7.72E-01	2.19E-03	2.21E-03	3.31E-04	3.28E+00
Cl-36	1.36E-03	6.72E-04	1.64E-05	4.93E-11	4.92E-04	1.16E-03	3.30E-06	3.33E-06	5.00E-07	4.95E-03
Co-60	0.00E+00									
Cs-137	1.24E-01	6.10E-02	1.48E-03	4.47E-09	4.46E-02	1.06E-01	2.99E-04	3.02E-04	4.53E-05	4.49E-01
H-3	1.84E+00	9.10E-01	2.21E-02	6.67E-08	6.65E-01	1.58E+00	4.47E-03	4.51E-03	6.77E-04	6.70E+00
I-129	4.76E-08	2.35E-08	5.72E-10	1.72E-15	1.72E-08	4.07E-08	1.15E-10	1.16E-10	1.75E-11	1.73E-07
Nb-94	7.54E-04	3.72E-04	9.05E-06	2.73E-11	2.72E-04	6.45E-04	1.83E-06	1.84E-06	2.77E-07	2.74E-03
Ni-59	1.08E-02	5.34E-03	1.30E-04	3.91E-10	3.90E-03	9.25E-03	2.62E-05	2.64E-05	3.97E-06	3.93E-02
Ni-63	1.37E+00	6.75E-01	1.64E-02	4.95E-08	4.94E-01	1.17E+00	3.32E-03	3.34E-03	5.02E-04	4.97E+00
Np-237	3.19E-07	1.58E-07	3.83E-09	1.15E-14	1.15E-07	2.73E-07	7.74E-10	7.80E-10	1.17E-10	1.16E-06
Pu-238	6.52E-04	3.22E-04	7.83E-06	2.36E-11	2.35E-04	5.58E-04	1.58E-06	1.59E-06	2.39E-07	2.37E-03
Pu-239	3.71E-03	1.83E-03	4.46E-05	1.34E-10	1.34E-03	3.18E-03	9.00E-06	9.08E-06	1.36E-06	1.35E-02
Pu-240	1.30E-03	6.41E-04	1.56E-05	4.70E-11	4.69E-04	1.11E-03	3.15E-06	3.17E-06	4.77E-07	4.72E-03
Pu-241	8.61E-02	4.25E-02	1.03E-03	3.12E-09	3.11E-02	7.36E-02	2.09E-04	2.11E-04	3.16E-05	3.13E-01
Sr-90	7.48E-02	3.69E-02	8.99E-04	2.71E-09	2.70E-02	6.40E-02	1.81E-04	1.83E-04	2.75E-05	2.72E-01
Tc-99	2.48E-05	1.22E-05	2.98E-07	8.98E-13	8.96E-06	2.12E-05	6.02E-08	6.07E-08	9.11E-09	9.02E-05
U-233	2.42E-05	1.19E-05	2.90E-07	8.75E-13	8.73E-06	2.07E-05	5.86E-08	5.91E-08	8.88E-09	8.79E-05
U-234	2.17E-06	1.07E-06	2.60E-08	7.84E-14	7.82E-07	1.85E-06	5.25E-09	5.29E-09	7.95E-10	7.87E-06
U-235	5.50E-08	2.72E-08	6.61E-10	1.99E-15	1.99E-08	4.71E-08	1.33E-10	1.35E-10	2.02E-11	2.00E-07
U-236	1.67E-07	8.26E-08	2.01E-09	6.05E-15	6.04E-08	1.43E-07	4.06E-10	4.09E-10	6.14E-11	6.08E-07
U-238	1.95E-06	9.60E-07	2.34E-08	7.04E-14	7.02E-07	1.66E-06	4.72E-09	4.76E-09	7.14E-10	7.07E-06

Table A-8. NRF-MOD-8H best estimate inventory summary (1956-1965).

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Am-241	1.54E-09	7.17E-06	1.18E-06	3.81E-07	1.11E-07	9.65E-05	1.67E-03	2.91E-06	1.17E-06	1.41E-09
C-14	3.50E-06	1.63E-02	2.69E-03	8.67E-04	2.53E-04	2.20E-01	3.79E+00	6.63E-03	2.65E-03	3.21E-06
Cl-36	0.00E+00									
Co-60	4.36E-04	2.03E+00	3.35E-01	1.08E-01	3.15E-02	2.74E+01	4.73E+02	8.26E-01	3.31E-01	4.00E-04
Cs-137	1.75E-07	8.17E-04	1.35E-04	4.35E-05	1.27E-05	1.10E-02	1.90E-01	3.32E-04	1.33E-04	1.61E-07
H-3	0.00E+00									
I-129	1.75E-11	8.17E-08	1.35E-08	4.35E-09	1.27E-09	1.10E-06	1.90E-05	3.32E-08	1.33E-08	1.61E-11
Nb-94	8.82E-08	4.11E-04	6.77E-05	2.18E-05	6.37E-06	5.53E-03	9.55E-02	1.67E-04	6.69E-05	8.08E-08
Ni-59	1.31E-06	6.12E-03	1.01E-03	3.25E-04	9.49E-05	8.24E-02	1.42E+00	2.49E-03	9.96E-04	1.20E-06
Ni-63	1.31E-04	6.12E-01	1.01E-01	3.25E-02	9.49E-03	8.24E+00	1.42E+02	2.49E-01	9.96E-02	1.20E-04
Np-237	1.31E-14	6.12E-11	1.01E-11	3.25E-12	9.49E-13	8.24E-10	1.42E-08	2.49E-11	9.96E-12	1.20E-14
Pu-238	1.10E-09	5.11E-06	8.43E-07	2.72E-07	7.93E-08	6.89E-05	1.19E-03	2.08E-06	8.32E-07	1.01E-09
Pu-239	1.75E-10	8.17E-07	1.35E-07	4.35E-08	1.27E-08	1.10E-05	1.90E-04	3.32E-07	1.33E-07	1.61E-10
Pu-240	1.10E-10	5.11E-07	8.43E-08	2.72E-08	7.93E-09	6.89E-06	1.19E-04	2.08E-07	8.32E-08	1.01E-10
Pu-241	4.36E-08	2.03E-04	3.35E-05	1.08E-05	3.15E-06	2.74E-03	4.73E-02	8.26E-05	3.31E-05	4.00E-08
Sr-90	1.75E-07	8.17E-04	1.35E-04	4.35E-05	1.27E-05	1.10E-02	1.90E-01	3.32E-04	1.33E-04	1.61E-07
Tc-99	4.36E-09	2.03E-05	3.35E-06	1.08E-06	3.15E-07	2.74E-04	4.73E-03	8.26E-06	3.31E-06	4.00E-09
U-233	1.18E-12	5.52E-09	9.09E-10	2.93E-10	8.56E-11	7.43E-08	1.28E-06	2.24E-09	8.98E-10	1.09E-12
U-234	1.31E-12	6.12E-09	1.01E-09	3.25E-10	9.49E-11	8.24E-08	1.42E-06	2.49E-09	9.96E-10	1.20E-12
U-235	9.25E-17	4.31E-13	7.10E-14	2.29E-14	6.68E-15	5.80E-12	1.00E-10	1.75E-13	7.01E-14	8.48E-17
U-236	4.84E-15	2.25E-11	3.72E-12	1.20E-12	3.50E-13	3.04E-10	5.25E-09	9.16E-12	3.67E-12	4.44E-15
U-238	2.15E-14	1.00E-10	1.65E-11	5.33E-12	1.55E-12	1.35E-09	2.33E-08	4.08E-11	1.63E-11	1.97E-14

Table A-8 (continued). NRF-MOD-8H best estimate inventory summary (1966-1971).

	1966	1967	1968	1969	1970	1971	Total
Am-241	1.91E-06	4.52E-08	5.16E-07	5.39E-07	1.55E-10	1.21E-07	1.78E-03
C-14	4.34E-03	1.03E-04	1.17E-03	1.23E-03	3.53E-07	2.75E-04	4.05E+00
Cl-36	0.00E+00						
Co-60	5.41E-01	1.28E-02	1.46E-01	1.53E-01	4.40E-05	3.42E-02	5.05E+02
Cs-137	2.18E-04	5.16E-06	5.89E-05	6.15E-05	1.77E-08	1.38E-05	2.03E-01
H-3	0.00E+00						
I-129	2.18E-08	5.16E-10	5.89E-09	6.15E-09	1.77E-12	1.38E-09	2.03E-05
Nb-94	1.09E-04	2.59E-06	2.96E-05	3.09E-05	8.90E-09	6.92E-06	1.02E-01
Ni-59	1.63E-03	3.86E-05	4.41E-04	4.60E-04	1.33E-07	1.03E-04	1.52E+00
Ni-63	1.63E-01	3.86E-03	4.41E-02	4.60E-02	1.33E-05	1.03E-02	1.52E+02
Np-237	1.63E-11	3.86E-13	4.41E-12	4.60E-12	1.33E-15	1.03E-12	1.52E-08
Pu-238	1.36E-06	3.23E-08	3.68E-07	3.84E-07	1.11E-10	8.61E-08	1.27E-03
Pu-239	2.18E-07	5.16E-09	5.89E-08	6.15E-08	1.77E-11	1.38E-08	2.03E-04
Pu-240	1.36E-07	3.23E-09	3.68E-08	3.84E-08	1.11E-11	8.61E-09	1.27E-04
Pu-241	5.41E-05	1.28E-06	1.46E-05	1.53E-05	4.40E-09	3.42E-06	5.05E-02
Sr-90	2.18E-04	5.16E-06	5.89E-05	6.15E-05	1.77E-08	1.38E-05	2.03E-01
Tc-99	5.41E-06	1.28E-07	1.46E-06	1.53E-06	4.40E-10	3.42E-07	5.05E-03
U-233	1.47E-09	3.48E-11	3.97E-10	4.15E-10	1.19E-13	9.29E-11	1.37E-06
U-234	1.63E-09	3.86E-11	4.41E-10	4.60E-10	1.33E-13	1.03E-10	1.52E-06
U-235	1.15E-13	2.72E-15	3.10E-14	3.24E-14	9.33E-18	7.26E-15	1.07E-10
U-236	6.00E-12	1.42E-13	1.62E-12	1.70E-12	4.88E-16	3.80E-13	5.60E-09
U-238	2.67E-11	6.33E-13	7.22E-12	7.54E-12	2.17E-15	1.69E-12	2.49E-08

Table A-9. NRF-MOD-9H best estimate inventory summary (1954-1965).

	1954	1955	1957	1958	1959	1960	1961	1963	1964	1965
Am-241	3.56E-05	5.45E-05	4.55E-05	1.64E-05	9.89E-06	1.84E-06	1.83E-05	7.04E-06	5.14E-07	1.48E-03
C-14	6.56E-02	1.00E-01	8.38E-02	3.03E-02	1.82E-02	3.40E-03	3.37E-02	1.30E-02	9.48E-04	2.73E+00
Cl-36	0.00E+00									
Co-60	1.01E+01	1.55E+01	1.29E+01	4.66E+00	2.81E+00	5.23E-01	5.18E+00	2.00E+00	1.46E-01	4.21E+02
Cs-137	4.06E-03	6.21E-03	5.18E-03	1.87E-03	1.13E-03	2.10E-04	2.08E-03	8.02E-04	5.86E-05	1.69E-01
H-3	0.00E+00									
I-129	4.02E-07	6.15E-07	5.13E-07	1.85E-07	1.12E-07	2.08E-08	2.06E-07	7.94E-08	5.80E-09	1.67E-05
Nb-94	2.03E-03	3.10E-03	2.59E-03	9.35E-04	5.63E-04	1.05E-04	1.04E-03	4.01E-04	2.93E-05	8.44E-02
Ni-59	3.04E-02	4.65E-02	3.89E-02	1.40E-02	8.45E-03	1.58E-03	1.56E-02	6.01E-03	4.39E-04	1.27E+00
Ni-63	3.04E+00	4.65E+00	3.89E+00	1.40E+00	8.45E-01	1.58E-01	1.56E+00	6.01E-01	4.39E-02	1.27E+02
Np-237	3.04E-10	4.65E-10	3.89E-10	1.40E-10	8.45E-11	1.58E-11	1.56E-10	6.01E-11	4.39E-12	1.27E-08
Pu-238	2.55E-05	3.89E-05	3.25E-05	1.17E-05	7.07E-06	1.32E-06	1.31E-05	5.03E-06	3.68E-07	1.06E-03
Pu-239	4.06E-06	6.21E-06	5.18E-06	1.87E-06	1.13E-06	2.10E-07	2.08E-06	8.02E-07	5.86E-08	1.69E-04
Pu-240	2.55E-06	3.89E-06	3.25E-06	1.17E-06	7.07E-07	1.32E-07	1.31E-06	5.03E-07	3.68E-08	1.06E-04
Pu-241	1.01E-03	1.55E-03	1.30E-03	4.68E-04	2.82E-04	5.25E-05	5.20E-04	2.00E-04	1.46E-05	4.22E-02
Sr-90	4.06E-03	6.21E-03	5.18E-03	1.87E-03	1.13E-03	2.10E-04	2.08E-03	8.02E-04	5.86E-05	1.69E-01
Tc-99	1.02E-04	1.56E-04	1.30E-04	4.69E-05	2.83E-05	5.27E-06	5.22E-05	2.01E-05	1.47E-06	4.24E-03
U-233	2.74E-08	4.20E-08	3.51E-08	1.27E-08	7.62E-09	1.42E-09	1.41E-08	5.42E-09	3.96E-10	1.14E-06
U-234	3.06E-08	4.69E-08	3.91E-08	1.41E-08	8.51E-09	1.59E-09	1.57E-08	6.05E-09	4.42E-10	1.28E-06
U-235	2.13E-12	3.26E-12	2.72E-12	9.81E-13	5.91E-13	1.10E-13	1.09E-12	4.21E-13	3.07E-14	8.86E-11
U-236	1.12E-10	1.71E-10	1.43E-10	5.15E-11	3.10E-11	5.79E-12	5.73E-11	2.21E-11	1.61E-12	4.65E-09
U-238	4.97E-10	7.61E-10	6.35E-10	2.29E-10	1.38E-10	2.58E-11	2.55E-10	9.83E-11	7.18E-12	2.07E-08

Table A-9 (continued). NRF-MOD-9H best estimate inventory summary (1966-1971).

	1966	1967	1968	1969	1970	1971	Total
Am-241	4.13E-06	7.15E-03	1.71E-05	2.13E-05	7.13E-05	1.83E-05	8.95E-03
C-14	7.62E-03	1.32E+01	3.15E-02	3.93E-02	1.31E-01	3.37E-02	1.65E+01
Cl-36	0.00E+00						
Co-60	1.17E+00	2.03E+03	4.84E+00	6.05E+00	2.02E+01	5.19E+00	2.54E+03
Cs-137	4.71E-04	8.14E-01	1.94E-03	2.43E-03	8.13E-03	2.08E-03	1.02E+00
H-3	0.00E+00						
I-129	4.66E-08	8.06E-05	1.93E-07	2.41E-07	8.05E-07	2.06E-07	1.01E-04
Nb-94	2.36E-04	4.07E-01	9.72E-04	1.22E-03	4.06E-03	1.04E-03	5.10E-01
Ni-59	3.53E-03	6.11E+00	1.46E-02	1.82E-02	6.10E-02	1.56E-02	7.65E+00
Ni-63	3.53E-01	6.11E+02	1.46E+00	1.82E+00	6.10E+00	1.56E+00	7.65E+02
Np-237	3.53E-11	6.11E-08	1.46E-10	1.82E-10	6.10E-10	1.56E-10	7.65E-08
Pu-238	2.96E-06	5.11E-03	1.22E-05	1.53E-05	5.10E-05	1.31E-05	6.40E-03
Pu-239	4.71E-07	8.14E-04	1.94E-06	2.43E-06	8.13E-06	2.08E-06	1.02E-03
Pu-240	2.96E-07	5.11E-04	1.22E-06	1.53E-06	5.10E-06	1.31E-06	6.40E-04
Pu-241	1.18E-04	2.04E-01	4.86E-04	6.08E-04	2.03E-03	5.21E-04	2.55E-01
Sr-90	4.71E-04	8.14E-01	1.94E-03	2.43E-03	8.13E-03	2.08E-03	1.02E+00
Tc-99	1.18E-05	2.04E-02	4.88E-05	6.10E-05	2.04E-04	5.23E-05	2.56E-02
U-233	3.19E-09	5.51E-06	1.32E-08	1.64E-08	5.50E-08	1.41E-08	6.90E-06
U-234	3.56E-09	6.15E-06	1.47E-08	1.83E-08	6.14E-08	1.57E-08	7.70E-06
U-235	2.47E-13	4.27E-10	1.02E-12	1.27E-12	4.26E-12	1.09E-12	5.35E-10
U-236	1.30E-11	2.24E-08	5.36E-11	6.70E-11	2.24E-10	5.74E-11	2.81E-08
U-238	5.77E-11	9.98E-08	2.38E-10	2.98E-10	9.96E-10	2.55E-10	1.25E-07

Table A-10. NRF-MOD-10H best estimate inventory summary (1953-1962).

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Am-241	4.86E-07	3.99E-06	9.01E-07	1.09E-05	5.22E-05	3.25E-05	1.50E-04	3.82E-01	6.99E-03	1.01E-05
C-14	0.00E+00									
Cl-36	0.00E+00									
Co-60	1.38E-01	1.13E+00	2.56E-01	3.10E+00	1.48E+01	9.23E+00	4.25E+01	1.08E+05	1.98E+03	2.86E+00
Cs-137	5.54E-05	4.55E-04	1.03E-04	1.24E-03	5.95E-03	3.71E-03	1.71E-02	4.35E+01	7.97E-01	1.15E-03
H-3	0.00E+00									
I-129	5.54E-09	4.55E-08	1.03E-08	1.24E-07	5.95E-07	3.71E-07	1.71E-06	4.35E-03	7.97E-05	1.15E-07
Nb-94	2.78E-05	2.28E-04	5.16E-05	6.25E-04	2.99E-03	1.86E-03	8.59E-03	2.19E+01	4.00E-01	5.77E-04
Ni-59	4.15E-04	3.40E-03	7.69E-04	9.32E-03	4.46E-02	2.78E-02	1.28E-01	3.26E+02	5.96E+00	8.60E-03
Ni-63	2.20E-02	1.80E-01	4.07E-02	4.94E-01	2.36E+00	1.47E+00	6.78E+00	1.73E+04	3.16E+02	4.56E-01
Np-237	4.15E-12	3.40E-11	7.69E-12	9.32E-11	4.46E-10	2.78E-10	1.28E-09	3.26E-06	5.96E-08	8.60E-11
Pu-238	3.46E-07	2.84E-06	6.43E-07	7.78E-06	3.72E-05	2.32E-05	1.07E-04	2.72E-01	4.98E-03	7.19E-06
Pu-239	5.54E-08	4.55E-07	1.03E-07	1.24E-06	5.95E-06	3.71E-06	1.71E-05	4.35E-02	7.97E-04	1.15E-06
Pu-240	3.46E-08	2.84E-07	6.43E-08	7.78E-07	3.72E-06	2.32E-06	1.07E-05	2.72E-02	4.98E-04	7.19E-07
Pu-241	1.37E-05	1.12E-04	2.54E-05	3.08E-04	1.47E-03	9.17E-04	4.23E-03	1.08E+01	1.97E-01	2.84E-04
Sr-90	5.54E-05	4.55E-04	1.03E-04	1.24E-03	5.95E-03	3.71E-03	1.71E-02	4.35E+01	7.97E-01	1.15E-03
Tc-99	1.38E-06	1.13E-05	2.56E-06	3.10E-05	1.48E-04	9.23E-05	4.25E-04	1.08E+00	1.98E-02	2.86E-05
U-233	3.74E-10	3.07E-09	6.93E-10	8.40E-09	4.02E-08	2.50E-08	1.15E-07	2.94E-04	5.38E-06	7.75E-09
U-234	4.15E-10	3.40E-09	7.69E-10	9.32E-09	4.46E-08	2.78E-08	1.28E-07	3.26E-04	5.96E-06	8.60E-09
U-235	2.92E-14	2.40E-13	5.41E-14	6.56E-13	3.14E-12	1.95E-12	9.02E-12	2.29E-08	4.20E-10	6.06E-13
U-236	1.53E-12	1.25E-11	2.83E-12	3.43E-11	1.64E-10	1.02E-10	4.72E-10	1.20E-06	2.20E-08	3.17E-11
U-238	6.79E-12	5.58E-11	1.26E-11	1.53E-10	7.30E-10	4.55E-10	2.10E-09	5.34E-06	9.77E-08	1.41E-10

Table A-10 (continued). NRF-MOD-10H best estimate inventory summary (1963-1972).

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Am-241	1.09E-05	1.64E-04	1.74E-02	3.31E-03	7.98E-03	6.03E-05	4.13E-05	2.08E-05	2.84E-05	9.78E-06
C-14	0.00E+00									
Cl-36	0.00E+00									
Co-60	3.09E+00	4.66E+01	4.94E+03	9.40E+02	2.27E+03	1.71E+01	1.17E+01	5.91E+00	8.04E+00	2.77E+00
Cs-137	1.24E-03	1.88E-02	1.98E+00	3.78E-01	9.11E-01	6.87E-03	4.70E-03	2.38E-03	3.23E-03	1.12E-03
H-3	0.00E+00									
I-129	1.24E-07	1.88E-06	1.98E-04	3.78E-05	9.11E-05	6.87E-07	4.70E-07	2.38E-07	3.23E-07	1.12E-07
Nb-94	6.24E-04	9.42E-03	9.97E-01	1.90E-01	4.58E-01	3.45E-03	2.36E-03	1.19E-03	1.62E-03	5.60E-04
Ni-59	9.30E-03	1.40E-01	1.49E+01	2.83E+00	6.82E+00	5.15E-02	3.52E-02	1.78E-02	2.42E-02	8.35E-03
Ni-63	4.93E-01	7.44E+00	7.87E+02	1.50E+02	3.61E+02	2.73E+00	1.87E+00	9.42E-01	1.28E+00	4.42E-01
Np-237	9.30E-11	1.40E-09	1.49E-07	2.83E-08	6.82E-08	5.15E-10	3.52E-10	1.78E-10	2.42E-10	8.35E-11
Pu-238	7.77E-06	1.17E-04	1.24E-02	2.36E-03	5.70E-03	4.30E-05	2.94E-05	1.49E-05	2.02E-05	6.98E-06
Pu-239	1.24E-06	1.88E-05	1.98E-03	3.78E-04	9.11E-04	6.87E-06	4.70E-06	2.38E-06	3.23E-06	1.12E-06
Pu-240	7.77E-07	1.17E-05	1.24E-03	2.36E-04	5.70E-04	4.30E-06	2.94E-06	1.49E-06	2.02E-06	6.98E-07
Pu-241	3.07E-04	4.64E-03	4.91E-01	9.34E-02	2.25E-01	1.70E-03	1.16E-03	5.87E-04	8.00E-04	2.76E-04
Sr-90	1.24E-03	1.88E-02	1.98E+00	3.78E-01	9.11E-01	6.87E-03	4.70E-03	2.38E-03	3.23E-03	1.12E-03
Tc-99	3.09E-05	4.66E-04	4.94E-02	9.40E-03	2.27E-02	1.71E-04	1.17E-04	5.91E-05	8.04E-05	2.77E-05
U-233	8.38E-09	1.27E-07	1.34E-05	2.55E-06	6.14E-06	4.64E-08	3.17E-08	1.60E-08	2.18E-08	7.53E-09
U-234	9.30E-09	1.40E-07	1.49E-05	2.83E-06	6.82E-06	5.15E-08	3.52E-08	1.78E-08	2.42E-08	8.35E-09
U-235	6.55E-13	9.88E-12	1.05E-09	1.99E-10	4.80E-10	3.62E-12	2.48E-12	1.25E-12	1.70E-12	5.88E-13
U-236	3.43E-11	5.17E-10	5.47E-08	1.04E-08	2.51E-08	1.90E-10	1.30E-10	6.55E-11	8.92E-11	3.08E-11
U-238	1.52E-10	2.30E-09	2.43E-07	4.63E-08	1.12E-07	8.43E-10	5.77E-10	2.91E-10	3.97E-10	1.37E-10

Table A-10 (continued). NRF-MOD-10H best estimate inventory summary (1973-1981).

	1973	1974	1975	1976	1977	1978	1979	1980	1981
Am-241	1.58E-04	2.06E-04	2.49E-05	1.37E-05	1.45E-06	1.55E-06	6.00E-06	2.32E-05	5.92E-04
C-14	-	-	-	-	-	-	-	-	-
Cl-36	-	-	-	-	-	-	-	-	-
Co-60	4.48E+01	5.84E+01	7.07E+00	3.88E+00	4.10E-01	4.39E-01	1.70E+00	6.57E+00	1.68E+02
Cs-137	1.80E-02	2.35E-02	2.84E-03	1.56E-03	1.65E-04	1.76E-04	6.84E-04	2.64E-03	6.75E-02
H-3	-	-	-	-	-	-	-	-	-
I-129	1.80E-06	2.35E-06	2.84E-07	1.56E-07	1.65E-08	1.76E-08	6.84E-08	2.64E-07	6.75E-06
Nb-94	9.04E-03	1.18E-02	1.43E-03	7.84E-04	8.29E-05	8.86E-05	3.44E-04	1.33E-03	3.39E-02
Ni-59	1.35E-01	1.76E-01	2.13E-02	1.17E-02	1.24E-03	1.32E-03	5.12E-03	1.98E-02	5.05E-01
Ni-63	7.14E+00	9.31E+00	1.13E+00	6.19E-01	6.54E-02	7.00E-02	2.71E-01	1.05E+00	2.68E+01
Np-237	1.35E-09	1.76E-09	2.13E-10	1.17E-10	1.24E-11	1.32E-11	5.12E-11	1.98E-10	5.05E-09
Pu-238	1.13E-04	1.47E-04	1.78E-05	9.76E-06	1.03E-06	1.10E-06	4.28E-06	1.65E-05	4.22E-04
Pu-239	1.80E-05	2.35E-05	2.84E-06	1.56E-06	1.65E-07	1.76E-07	6.84E-07	2.64E-06	6.75E-05
Pu-240	1.13E-05	1.47E-05	1.78E-06	9.76E-07	1.03E-07	1.10E-07	4.28E-07	1.65E-06	4.22E-05
Pu-241	4.45E-03	5.80E-03	7.03E-04	3.86E-04	4.08E-05	4.36E-05	1.69E-04	6.53E-04	1.67E-02
Sr-90	1.80E-02	2.35E-02	2.84E-03	1.56E-03	1.65E-04	1.76E-04	6.84E-04	2.64E-03	6.75E-02
Tc-99	4.48E-04	5.84E-04	7.07E-05	3.88E-05	4.10E-06	4.39E-06	1.70E-05	6.57E-05	1.68E-03
U-233	1.21E-07	1.58E-07	1.92E-08	1.05E-08	1.11E-09	1.19E-09	4.61E-09	1.78E-08	4.56E-07
U-234	1.35E-07	1.76E-07	2.13E-08	1.17E-08	1.24E-09	1.32E-09	5.12E-09	1.98E-08	5.05E-07
U-235	9.48E-12	1.24E-11	1.50E-12	8.22E-13	8.69E-14	9.30E-14	3.60E-13	1.39E-12	3.56E-11
U-236	4.96E-10	6.47E-10	7.85E-11	4.30E-11	4.55E-12	4.87E-12	1.89E-11	7.28E-11	1.86E-09
U-238	2.21E-09	2.88E-09	3.49E-10	1.91E-10	2.02E-11	2.16E-11	8.39E-11	3.24E-10	8.28E-09

Table A-10 (continued). NRF-MOD-10H best estimate inventory summary (1982-1983).

	1982	1983	Total
Am-241	4.96E-06	7.41E-06	4.19E-01
C-14	0.00E+00	0.00E+00	0.00E+00
Cl-36	0.00E+00	0.00E+00	0.00E+00
Co-60	1.41E+00	2.10E+00	1.19E+05
Cs-137	5.66E-04	8.45E-04	4.78E+01
H-3	0.00E+00	0.00E+00	0.00E+00
I-129	5.66E-08	8.45E-08	4.78E-03
Nb-94	2.84E-04	4.25E-04	2.40E+01
Ni-59	4.24E-03	6.33E-03	3.58E+02
Ni-63	2.24E-01	3.35E-01	1.90E+04
Np-237	4.24E-11	6.33E-11	3.58E-06
Pu-238	3.54E-06	5.29E-06	2.99E-01
Pu-239	5.66E-07	8.45E-07	4.78E-02
Pu-240	3.54E-07	5.29E-07	2.99E-02
Pu-241	1.40E-04	2.09E-04	1.18E+01
Sr-90	5.66E-04	8.45E-04	4.78E+01
Tc-99	1.41E-05	2.10E-05	1.19E+00
U-233	3.82E-09	5.70E-09	3.23E-04
U-234	4.24E-09	6.33E-09	3.58E-04
U-235	2.98E-13	4.45E-13	2.52E-08
U-236	1.56E-11	2.33E-11	1.32E-06
U-238	6.94E-11	1.04E-10	5.86E-06

Table A-11. NRF-MOD-1H upper-bound estimate inventory summary (1962-1968).

	1962	1965	1967	1968	Total
Am-241	2.80E-01	1.24E-01	2.09E-01	1.56E+01	1.62E+01
C-14	7.36E-04	3.26E-04	5.49E-04	4.10E-02	4.26E-02
Cl-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	2.75E+02	1.22E+02	2.05E+02	1.53E+04	1.59E+04
H-3	1.20E+00	5.30E-01	8.93E-01	6.67E+01	6.93E+01
I-129	1.01E-04	4.47E-05	7.54E-05	5.63E-03	5.85E-03
Nb-94	3.56E-07	1.57E-07	2.65E-07	1.98E-05	2.06E-05
Ni-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-237	6.90E-05	3.05E-05	5.14E-05	3.84E-03	3.99E-03
Pu-238	3.06E-01	1.35E-01	2.28E-01	1.70E+01	1.77E+01
Pu-239	1.15E+00	5.08E-01	8.57E-01	6.40E+01	6.65E+01
Pu-240	1.00E+00	4.43E-01	7.46E-01	5.57E+01	5.79E+01
Pu-241	7.86E+01	3.48E+01	5.86E+01	4.38E+03	4.55E+03
Sr-90	1.62E+02	7.15E+01	1.21E+02	9.01E+03	9.36E+03
Tc-99	3.87E-02	1.71E-02	2.89E-02	2.16E+00	2.24E+00
U-233	2.49E-08	1.10E-08	1.85E-08	1.39E-06	1.44E-06
U-234	1.20E-03	5.31E-04	8.95E-04	6.69E-02	6.95E-02
U-235	2.54E-05	1.12E-05	1.89E-05	1.41E-03	1.47E-03
U-236	1.73E-04	7.64E-05	1.29E-04	9.62E-03	1.00E-02
U-238	1.38E-03	6.09E-04	1.03E-03	7.67E-02	7.97E-02

Table A-12. NRF-MOD-2H upper-bound estimate inventory summary (1960-1964).

	1960	1961	1962	1964	Total
Am-241	8.03E-02	9.69E-02	2.27E-01	2.24E-02	4.27E-01
C-14	2.11E-04	2.54E-04	5.97E-04	5.86E-05	1.12E-03
Cl-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	7.90E+01	9.53E+01	2.24E+02	2.20E+01	4.20E+02
H-3	3.44E-01	4.15E-01	9.75E-01	9.58E-02	1.83E+00
I-129	2.91E-05	3.52E-05	8.26E-05	8.12E-06	1.55E-04
Nb-94	1.02E-07	1.23E-07	2.89E-07	2.84E-08	5.43E-07
Ni-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-237	1.97E-05	2.38E-05	5.59E-05	5.50E-06	1.05E-04
Pu-238	8.78E-02	1.06E-01	2.49E-01	2.45E-02	4.67E-01
Pu-239	3.29E-01	3.97E-01	9.32E-01	9.16E-02	1.75E+00
Pu-240	2.88E-01	3.47E-01	8.15E-01	8.01E-02	1.53E+00
Pu-241	2.26E+01	2.72E+01	6.39E+01	6.28E+00	1.20E+02
Sr-90	4.66E+01	5.63E+01	1.32E+02	1.30E+01	2.48E+02
Tc-99	1.11E-02	1.34E-02	3.14E-02	3.09E-03	5.90E-02
U-233	7.14E-09	8.62E-09	2.02E-08	1.99E-09	3.80E-08
U-234	2.88E-04	3.47E-04	8.15E-04	8.01E-05	1.53E-03
U-235	4.68E-06	5.65E-06	1.33E-05	1.30E-06	2.49E-05
U-236	4.98E-05	6.01E-05	1.41E-04	1.39E-05	2.65E-04
U-238	3.40E-04	4.11E-04	9.64E-04	9.48E-05	1.81E-03

Table A-13. NRF-MOD-3H upper-bound estimate inventory summary (1955-1970).

	1955	1956	1957	1968	1969	1970	Total
Am-241	1.56E-07	1.56E-05	3.90E-03	7.78E-05	2.33E-04	5.39E-05	4.28E-03
C-14	1.55E-11	1.55E-09	3.87E-07	7.73E-09	2.32E-08	5.36E-09	4.25E-07
Cl-36	0.00E+00						
Co-60	0.00E+00						
Cs-137	1.36E-02	1.36E+00	3.40E+02	6.78E+00	2.03E+01	4.70E+00	3.73E+02
H-3	5.34E-05	5.34E-03	1.34E+00	2.67E-02	8.02E-02	1.85E-02	1.47E+00
I-129	3.23E-09	3.23E-07	8.10E-05	1.62E-06	4.85E-06	1.12E-06	8.89E-05
Nb-94	5.64E-12	5.64E-10	1.41E-07	2.82E-09	8.45E-09	1.95E-09	1.55E-07
Ni-59	0.00E+00						
Ni-63	0.00E+00						
Np-237	6.36E-08	6.36E-06	1.59E-03	3.18E-05	9.54E-05	2.21E-05	1.75E-03
Pu-238	2.45E-04	2.45E-02	6.15E+00	1.23E-01	3.68E-01	8.51E-02	6.75E+00
Pu-239	5.05E-07	5.05E-05	1.27E-02	2.53E-04	7.58E-04	1.75E-04	1.39E-02
Pu-240	1.46E-07	1.46E-05	3.65E-03	7.29E-05	2.19E-04	5.05E-05	4.01E-03
Pu-241	7.45E-05	7.45E-03	1.87E+00	3.73E-02	1.12E-01	2.58E-02	2.05E+00
Sr-90	1.35E-02	1.35E+00	3.38E+02	6.74E+00	2.02E+01	4.68E+00	3.71E+02
Tc-99	1.87E-06	1.87E-04	4.67E-02	9.33E-04	2.80E-03	6.47E-04	5.13E-02
U-233	1.86E-11	1.86E-09	4.66E-07	9.31E-09	2.79E-08	6.45E-09	5.12E-07
U-234	3.06E-07	3.06E-05	7.66E-03	1.53E-04	4.59E-04	1.06E-04	8.41E-03
U-235	3.74E-09	3.74E-07	9.38E-05	1.87E-06	5.62E-06	1.30E-06	1.03E-04
U-236	3.82E-08	3.82E-06	9.57E-04	1.91E-05	5.73E-05	1.32E-05	1.05E-03
U-238	1.64E-11	1.64E-09	4.10E-07	8.18E-09	2.45E-08	5.67E-09	4.50E-07

Table A-14. NRF-MOD-4H upper-bound estimate inventory summary (1970-1973).

	1970	1973	Total
Am-241	5.59E-04	2.18E-03	2.74E-03
C-14	5.55E-08	2.16E-07	2.72E-07
Cl-36	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00
Cs-137	4.88E+01	1.90E+02	2.39E+02
H-3	1.92E-01	7.49E-01	9.41E-01
I-129	1.16E-05	4.53E-05	5.69E-05
Nb-94	2.02E-08	7.88E-08	9.90E-08
Ni-59	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00
Np-237	2.29E-04	8.91E-04	1.12E-03
Pu-238	8.82E-01	3.44E+00	4.32E+00
Pu-239	1.82E-03	7.11E-03	8.93E-03
Pu-240	5.22E-04	2.04E-03	2.56E-03
Pu-241	2.67E-01	1.04E+00	1.31E+00
Sr-90	4.86E+01	1.89E+02	2.38E+02
Tc-99	6.71E-03	2.62E-02	3.29E-02
U-233	6.69E-08	2.61E-07	3.28E-07
U-234	1.10E-03	4.29E-03	5.39E-03
U-235	1.35E-05	5.25E-05	6.60E-05
U-236	1.38E-04	5.36E-04	6.74E-04
U-238	5.88E-08	2.29E-07	2.88E-07

Table A-15. NRF-MOD-5H upper-bound estimate inventory summary (1963-1970).

	1963	1970	Total
Am-241	3.76E-01	2.25E-04	3.76E-01
C-14	9.89E-04	5.94E-07	9.90E-04
Cl-36	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00
Cs-137	3.69E+02	2.21E-01	3.69E+02
H-3	1.61E+00	9.65E-04	1.61E+00
I-129	1.36E-04	8.16E-08	1.36E-04
Nb-94	4.79E-07	2.87E-10	4.79E-07
Ni-59	0.00E+00	0.00E+00	0.00E+00
Ni-63	0.00E+00	0.00E+00	0.00E+00
Np-237	9.26E-05	5.56E-08	9.27E-05
Pu-238	4.13E-01	2.48E-04	4.13E-01
Pu-239	1.54E+00	9.23E-04	1.54E+00
Pu-240	1.35E+00	8.10E-04	1.35E+00
Pu-241	1.06E+02	6.36E-02	1.06E+02
Sr-90	2.18E+02	1.31E-01	2.18E+02
Tc-99	5.19E-02	3.11E-05	5.19E-02
U-233	3.35E-08	2.01E-11	3.35E-08
U-234	1.35E-03	8.10E-07	1.35E-03
U-235	2.20E-05	1.32E-08	2.20E-05
U-236	2.33E-04	1.40E-07	2.33E-04
U-238	1.59E-03	9.53E-07	1.59E-03

Table A-16. NRF-MOD-6H upper-bound estimate inventory summary (1954-1964).

	1954	1955	1956	1957	1958	1959	1960	1961	1963	1964
Am-241	2.07E-07	2.02E-04	2.28E-05	7.81E-06	1.62E-05	5.37E-04	9.71E-07	1.55E-06	8.86E-05	7.07E-04
C-14	7.23E-05	7.07E-02	7.99E-03	2.73E-03	5.66E-03	1.88E-01	3.40E-04	5.44E-04	3.10E-02	2.47E-01
Cl-36	2.99E-07	2.92E-04	3.30E-05	1.13E-05	2.34E-05	7.77E-04	1.40E-06	2.25E-06	1.28E-04	1.02E-03
Co-60	8.85E-01	8.66E+02	9.78E+01	3.35E+01	6.93E+01	2.30E+03	4.16E+00	6.66E+00	3.80E+02	3.03E+03
Cs-137	1.33E-05	1.30E-02	1.47E-03	5.02E-04	1.04E-03	3.45E-02	6.24E-05	9.98E-05	5.69E-03	4.54E-02
H-3	1.99E-04	1.95E-01	2.20E-02	7.53E-03	1.56E-02	5.18E-01	9.36E-04	1.50E-03	8.54E-02	6.81E-01
I-129	7.16E-11	7.00E-08	7.91E-09	2.71E-09	5.60E-09	1.86E-07	3.36E-10	5.38E-10	3.07E-08	2.45E-07
Nb-94	9.59E-06	9.38E-03	1.06E-03	3.63E-04	7.51E-04	2.49E-02	4.51E-05	7.21E-05	4.11E-03	3.28E-02
Ni-59	2.14E-03	2.09E+00	2.36E-01	8.09E-02	1.68E-01	5.56E+00	1.01E-02	1.61E-02	9.17E-01	7.32E+00
Ni-63	2.51E-01	2.45E+02	2.77E+01	9.49E+00	1.96E+01	6.52E+02	1.18E+00	1.89E+00	1.08E+02	8.58E+02
Np-237	0.00E+00									
Pu-238	1.33E-07	1.30E-04	1.47E-05	5.02E-06	1.04E-05	3.45E-04	6.24E-07	9.98E-07	5.69E-05	4.54E-04
Pu-239	3.10E-07	3.03E-04	3.42E-05	1.17E-05	2.43E-05	8.06E-04	1.46E-06	2.33E-06	1.33E-04	1.06E-03
Pu-240	1.92E-07	1.88E-04	2.12E-05	7.25E-06	1.50E-05	4.99E-04	9.02E-07	1.44E-06	8.23E-05	6.56E-04
Pu-241	1.62E-05	1.59E-02	1.79E-03	6.14E-04	1.27E-03	4.22E-02	7.63E-05	1.22E-04	6.96E-03	5.55E-02
Sr-90	7.08E-06	6.92E-03	7.82E-04	2.68E-04	5.55E-04	1.84E-02	3.33E-05	5.32E-05	3.04E-03	2.42E-02
Tc-99	3.84E-08	3.75E-05	4.24E-06	1.45E-06	3.00E-06	9.97E-05	1.80E-07	2.88E-07	1.65E-05	1.31E-04
U-233	0.00E+00									
U-234	2.07E-10	2.02E-07	2.28E-08	7.81E-09	1.62E-08	5.37E-07	9.71E-10	1.55E-09	8.86E-08	7.07E-07
U-235	5.90E-12	5.77E-09	6.52E-10	2.23E-10	4.62E-10	1.53E-08	2.77E-11	4.44E-11	2.53E-09	2.02E-08
U-236	1.92E-11	1.88E-08	2.12E-09	7.25E-10	1.50E-09	4.99E-08	9.02E-11	1.44E-10	8.23E-09	6.56E-08
U-238	2.21E-10	2.16E-07	2.45E-08	8.37E-09	1.73E-08	5.75E-07	1.04E-09	1.66E-09	9.49E-08	7.57E-07

Table A-16 (continued). NRF-MOD-6H upper-bound estimate inventory summary (1965-1974).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Am-241	1.91E-02	4.82E-02	4.94E-02	8.51E-03	4.85E-02	1.03E-02	5.02E-04	6.99E-04	5.16E-04	3.16E-04
C-14	6.69E+00	1.69E+01	1.73E+01	2.98E+00	1.70E+01	3.62E+00	1.76E-01	2.45E-01	1.80E-01	1.11E-01
Cl-36	2.76E-02	6.97E-02	7.14E-02	1.23E-02	7.01E-02	1.50E-02	7.26E-04	1.01E-03	7.46E-04	4.58E-04
Co-60	8.19E+04	2.07E+05	2.12E+05	3.65E+04	2.08E+05	4.43E+04	2.15E+03	2.99E+03	2.21E+03	1.36E+03
Cs-137	1.23E+00	3.10E+00	3.17E+00	5.47E-01	3.12E+00	6.65E-01	3.23E-02	4.49E-02	3.31E-02	2.03E-02
H-3	1.84E+01	4.65E+01	4.76E+01	8.20E+00	4.67E+01	9.97E+00	4.84E-01	6.74E-01	4.97E-01	3.05E-01
I-129	6.62E-06	1.67E-05	1.71E-05	2.95E-06	1.68E-05	3.58E-06	1.74E-07	2.42E-07	1.79E-07	1.10E-07
Nb-94	8.87E-01	2.24E+00	2.29E+00	3.95E-01	2.25E+00	4.80E-01	2.33E-02	3.24E-02	2.39E-02	1.47E-02
Ni-59	1.98E+02	4.99E+02	5.11E+02	8.81E+01	5.02E+02	1.07E+02	5.20E+00	7.24E+00	5.34E+00	3.28E+00
Ni-63	2.32E+04	5.85E+04	6.00E+04	1.03E+04	5.89E+04	1.26E+04	6.09E+02	8.48E+02	6.26E+02	3.84E+02
Np-237	0.00E+00									
Pu-238	1.23E-02	3.10E-02	3.17E-02	5.47E-03	3.12E-02	6.65E-03	3.23E-04	4.49E-04	3.31E-04	2.03E-04
Pu-239	2.87E-02	7.23E-02	7.41E-02	1.28E-02	7.27E-02	1.55E-02	7.53E-04	1.05E-03	7.73E-04	4.75E-04
Pu-240	1.77E-02	4.48E-02	4.58E-02	7.90E-03	4.50E-02	9.60E-03	4.66E-04	6.49E-04	4.79E-04	2.94E-04
Pu-241	1.50E+00	3.79E+00	3.88E+00	6.68E-01	3.81E+00	8.13E-01	3.94E-02	5.49E-02	4.05E-02	2.49E-02
Sr-90	6.55E-01	1.65E+00	1.69E+00	2.92E-01	1.66E+00	3.55E-01	1.72E-02	2.40E-02	1.77E-02	1.09E-02
Tc-99	3.55E-03	8.95E-03	9.17E-03	1.58E-03	9.00E-03	1.92E-03	9.32E-05	1.30E-04	9.57E-05	5.88E-05
U-233	0.00E+00									
U-234	1.91E-05	4.82E-05	4.94E-05	8.51E-06	4.85E-05	1.03E-05	5.02E-07	6.99E-07	5.16E-07	3.16E-07
U-235	5.46E-07	1.38E-06	1.41E-06	2.43E-07	1.38E-06	2.96E-07	1.43E-08	2.00E-08	1.47E-08	9.04E-09
U-236	1.77E-06	4.48E-06	4.58E-06	7.90E-07	4.50E-06	9.60E-07	4.66E-08	6.49E-08	4.79E-08	2.94E-08
U-238	2.05E-05	5.16E-05	5.29E-05	9.11E-06	5.19E-05	1.11E-05	5.38E-07	7.49E-07	5.52E-07	3.39E-07

Table A-16 (continued). NRF-MOD-6H upper-bound estimate inventory summary (1975-1983).

	1975	1976	1977	1978	1979	1980	1981	1982	1983	Total
Am-241	3.20E-04	4.76E-03	9.37E-03	2.27E-03	7.18E-03	2.54E-03	1.10E-03	4.58E-04	2.53E-03	2.18E-01
C-14	1.12E-01	1.67E+00	3.28E+00	7.95E-01	2.51E+00	8.88E-01	3.85E-01	1.60E-01	8.84E-01	7.63E+01
Cl-36	4.63E-04	6.89E-03	1.35E-02	3.29E-03	1.04E-02	3.67E-03	1.59E-03	6.62E-04	3.65E-03	3.16E-01
Co-60	1.37E+03	2.04E+04	4.01E+04	9.73E+03	3.08E+04	1.09E+04	4.71E+03	1.96E+03	1.08E+04	9.35E+05
Cs-137	2.06E-02	3.06E-01	6.02E-01	1.46E-01	4.62E-01	1.63E-01	7.07E-02	2.94E-02	1.62E-01	1.40E+01
H-3	3.09E-01	4.59E+00	9.03E+00	2.19E+00	6.93E+00	2.45E+00	1.06E+00	4.41E-01	2.43E+00	2.10E+02
I-129	1.11E-07	1.65E-06	3.24E-06	7.87E-07	2.49E-06	8.79E-07	3.81E-07	1.58E-07	8.75E-07	7.56E-05
Nb-94	1.49E-02	2.21E-01	4.35E-01	1.05E-01	3.34E-01	1.18E-01	5.10E-02	2.12E-02	1.17E-01	1.01E+01
Ni-59	3.32E+00	4.93E+01	9.70E+01	2.35E+01	7.44E+01	2.63E+01	1.14E+01	4.74E+00	2.62E+01	2.26E+03
Ni-63	3.89E+02	5.79E+03	1.14E+04	2.76E+03	8.72E+03	3.08E+03	1.34E+03	5.56E+02	3.07E+03	2.65E+05
Np-237	0.00E+00									
Pu-238	2.06E-04	3.06E-03	6.02E-03	1.46E-03	4.62E-03	1.63E-03	7.07E-04	2.94E-04	1.62E-03	1.40E-01
Pu-239	4.80E-04	7.15E-03	1.40E-02	3.41E-03	1.08E-02	3.81E-03	1.65E-03	6.86E-04	3.79E-03	3.27E-01
Pu-240	2.97E-04	4.42E-03	8.70E-03	2.11E-03	6.67E-03	2.36E-03	1.02E-03	4.25E-04	2.34E-03	2.03E-01
Pu-241	2.52E-02	3.74E-01	7.36E-01	1.78E-01	5.65E-01	1.99E-01	8.64E-02	3.59E-02	1.98E-01	1.71E+01
Sr-90	1.10E-02	1.63E-01	3.21E-01	7.79E-02	2.46E-01	8.70E-02	3.77E-02	1.57E-02	8.66E-02	7.48E+00
Tc-99	5.95E-05	8.85E-04	1.74E-03	4.22E-04	1.33E-03	4.71E-04	2.04E-04	8.50E-05	4.69E-04	4.05E-02
U-233	0.00E+00									
U-234	3.20E-07	4.76E-06	9.37E-06	2.27E-06	7.18E-06	2.54E-06	1.10E-06	4.58E-07	2.53E-06	2.18E-04
U-235	9.15E-09	1.36E-07	2.68E-07	6.49E-08	2.05E-07	7.25E-08	3.14E-08	1.31E-08	7.21E-08	6.23E-06
U-236	2.97E-08	4.42E-07	8.70E-07	2.11E-07	6.67E-07	2.36E-07	1.02E-07	4.25E-08	2.34E-07	2.03E-05
U-238	3.43E-07	5.10E-06	1.00E-05	2.43E-06	7.70E-06	2.72E-06	1.18E-06	4.90E-07	2.71E-06	2.34E-04

Table A-17. NRF-MOD-7H upper-bound estimate inventory summary (1955-1964).

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Am-241	3.99E-11	1.39E-05	4.20E-06	1.60E-06	2.79E-05	2.12E-05	1.68E-04	1.90E-04	5.07E-04	6.70E-05
C-14	7.35E-08	2.57E-02	7.73E-03	2.94E-03	5.14E-02	3.91E-02	3.09E-01	3.50E-01	9.34E-01	1.23E-01
Cl-36	1.11E-10	3.86E-05	1.16E-05	4.42E-06	7.73E-05	5.87E-05	4.64E-04	5.27E-04	1.40E-03	1.85E-04
Co-60	0.00E+00									
Cs-137	1.01E-08	3.51E-03	1.06E-03	4.02E-04	7.03E-03	5.34E-03	4.22E-02	4.80E-02	1.28E-01	1.69E-02
H-3	1.50E-07	5.25E-02	1.58E-02	6.01E-03	1.05E-01	7.99E-02	6.31E-01	7.17E-01	1.91E+00	2.52E-01
I-129	3.87E-15	1.35E-09	4.07E-10	1.55E-10	2.71E-09	2.06E-09	1.63E-08	1.85E-08	4.92E-08	6.50E-09
Nb-94	6.14E-11	2.14E-05	6.46E-06	2.46E-06	4.30E-05	3.26E-05	2.58E-04	2.93E-04	7.81E-04	1.03E-04
Ni-59	8.80E-10	3.07E-04	9.25E-05	3.52E-05	6.15E-04	4.68E-04	3.70E-03	4.20E-03	1.12E-02	1.48E-03
Ni-63	1.12E-07	3.89E-02	1.17E-02	4.46E-03	7.80E-02	5.93E-02	4.68E-01	5.32E-01	1.42E+00	1.87E-01
Np-237	2.60E-14	9.07E-09	2.73E-09	1.04E-09	1.82E-08	1.38E-08	1.09E-07	1.24E-07	3.30E-07	4.36E-08
Pu-238	5.31E-11	1.85E-05	5.58E-06	2.12E-06	3.71E-05	2.82E-05	2.23E-04	2.53E-04	6.75E-04	8.90E-05
Pu-239	3.03E-10	1.06E-04	3.18E-05	1.21E-05	2.12E-04	1.61E-04	1.27E-03	1.44E-03	3.85E-03	5.08E-04
Pu-240	1.06E-10	3.68E-05	1.11E-05	4.22E-06	7.38E-05	5.61E-05	4.43E-04	5.03E-04	1.34E-03	1.77E-04
Pu-241	7.01E-09	2.45E-03	7.37E-04	2.80E-04	4.90E-03	3.73E-03	2.94E-02	3.34E-02	8.91E-02	1.18E-02
Sr-90	6.09E-09	2.13E-03	6.41E-04	2.44E-04	4.26E-03	3.24E-03	2.56E-02	2.91E-02	7.75E-02	1.02E-02
Tc-99	2.02E-12	7.06E-07	2.13E-07	8.08E-08	1.41E-06	1.07E-06	8.49E-06	9.64E-06	2.57E-05	3.39E-06
U-233	1.31E-12	4.59E-07	1.38E-07	5.26E-08	9.19E-07	6.98E-07	5.52E-06	6.27E-06	1.67E-05	2.20E-06
U-234	1.17E-13	4.10E-08	1.24E-08	4.70E-09	8.21E-08	6.24E-08	4.93E-07	5.60E-07	1.49E-06	1.97E-07
U-235	2.99E-15	1.04E-09	3.14E-10	1.19E-10	2.09E-09	1.59E-09	1.25E-08	1.42E-08	3.80E-08	5.01E-09
U-236	9.08E-15	3.17E-09	9.55E-10	3.63E-10	6.35E-09	4.83E-09	3.81E-08	4.33E-08	1.15E-07	1.52E-08
U-238	1.06E-13	3.68E-08	1.11E-08	4.22E-09	7.38E-08	5.61E-08	4.43E-07	5.03E-07	1.34E-06	1.77E-07

Table A-17 (continued). NRF-MOD-7H upper-bound estimate inventory summary (1965-1975).

	1965	1966	1967	1968	1970	1971	1973	1974	1975	Total
Am-241	1.10E-03	5.44E-04	1.32E-05	3.99E-11	3.98E-04	9.43E-04	2.67E-06	2.70E-06	4.05E-07	4.01E-03
C-14	2.03E+00	1.00E+00	2.44E-02	7.35E-08	7.33E-01	1.74E+00	4.92E-03	4.96E-03	7.45E-04	7.38E+00
Cl-36	3.05E-03	1.51E-03	3.67E-05	1.11E-10	1.10E-03	2.61E-03	7.40E-06	7.47E-06	1.12E-06	1.11E-02
Co-60	0.00E+00									
Cs-137	2.78E-01	1.37E-01	3.34E-03	1.01E-08	1.00E-01	2.38E-01	6.74E-04	6.79E-04	1.02E-04	1.01E+00
H-3	4.15E+00	2.05E+00	4.99E-02	1.50E-07	1.50E+00	3.55E+00	1.01E-02	1.02E-02	1.52E-03	1.51E+01
I-129	1.07E-07	5.28E-08	1.29E-09	3.87E-15	3.86E-08	9.15E-08	2.59E-10	2.62E-10	3.93E-11	3.89E-07
Nb-94	1.70E-03	8.38E-04	2.04E-05	6.14E-11	6.13E-04	1.45E-03	4.12E-06	4.15E-06	6.23E-07	6.17E-03
Ni-59	2.43E-02	1.20E-02	2.92E-04	8.80E-10	8.78E-03	2.08E-02	5.90E-05	5.95E-05	8.93E-06	8.84E-02
Ni-63	3.08E+00	1.52E+00	3.70E-02	1.12E-07	1.11E+00	2.63E+00	7.47E-03	7.53E-03	1.13E-03	1.12E+01
Np-237	7.18E-07	3.54E-07	8.62E-09	2.60E-14	2.59E-07	6.14E-07	1.74E-09	1.76E-09	2.64E-10	2.61E-06
Pu-238	1.47E-03	7.24E-04	1.76E-05	5.31E-11	5.29E-04	1.25E-03	3.56E-06	3.59E-06	5.38E-07	5.33E-03
Pu-239	8.36E-03	4.13E-03	1.00E-04	3.03E-10	3.02E-03	7.15E-03	2.03E-05	2.04E-05	3.07E-06	3.04E-02
Pu-240	2.92E-03	1.44E-03	3.50E-05	1.06E-10	1.05E-03	2.49E-03	7.07E-06	7.13E-06	1.07E-06	1.06E-02
Pu-241	1.94E-01	9.56E-02	2.33E-03	7.01E-09	6.99E-02	1.66E-01	4.70E-04	4.74E-04	7.11E-05	7.04E-01
Sr-90	1.68E-01	8.31E-02	2.02E-03	6.09E-09	6.08E-02	1.44E-01	4.08E-04	4.12E-04	6.18E-05	6.12E-01
Tc-99	5.59E-05	2.76E-05	6.71E-07	2.02E-12	2.02E-05	4.78E-05	1.35E-07	1.37E-07	2.05E-08	2.03E-04
U-233	3.63E-05	1.79E-05	4.36E-07	1.31E-12	1.31E-05	3.11E-05	8.80E-08	8.88E-08	1.33E-08	1.32E-04
U-234	3.25E-06	1.60E-06	3.90E-08	1.17E-13	1.17E-06	2.78E-06	7.87E-09	7.94E-09	1.19E-09	1.18E-05
U-235	8.25E-08	4.07E-08	9.91E-10	2.99E-15	2.98E-08	7.06E-08	2.00E-10	2.02E-10	3.03E-11	3.00E-07
U-236	2.51E-07	1.24E-07	3.01E-09	9.08E-15	9.06E-08	2.15E-07	6.08E-10	6.13E-10	9.21E-11	9.12E-07
U-238	2.92E-06	1.44E-06	3.50E-08	1.06E-13	1.05E-06	2.49E-06	7.07E-09	7.13E-09	1.07E-09	1.06E-05

Table A-18. NRF-MOD-8H upper-bound estimate inventory summary (1956-1965).

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Am-241	3.07E-09	1.43E-05	2.36E-06	7.60E-07	2.22E-07	1.93E-04	3.33E-03	5.81E-06	2.33E-06	2.81E-09
C-14	7.00E-06	3.26E-02	5.38E-03	1.73E-03	5.06E-04	4.39E-01	7.59E+00	1.33E-02	5.31E-03	6.42E-06
Cl-36	0.00E+00									
Co-60	8.73E-04	4.07E+00	6.70E-01	2.16E-01	6.31E-02	5.48E+01	9.46E+02	1.65E+00	6.62E-01	8.00E-04
Cs-137	3.50E-07	1.63E-03	2.69E-04	8.67E-05	2.53E-05	2.20E-02	3.79E-01	6.63E-04	2.65E-04	3.21E-07
H-3	0.00E+00									
I-129	3.51E-11	1.63E-07	2.69E-08	8.69E-09	2.54E-09	2.20E-06	3.80E-05	6.64E-08	2.66E-08	3.22E-11
Nb-94	1.75E-07	8.17E-04	1.35E-04	4.35E-05	1.27E-05	1.10E-02	1.90E-01	3.32E-04	1.33E-04	1.61E-07
Ni-59	2.63E-06	1.22E-02	2.02E-03	6.51E-04	1.90E-04	1.65E-01	2.85E+00	4.98E-03	1.99E-03	2.41E-06
Ni-63	2.63E-04	1.22E+00	2.02E-01	6.51E-02	1.90E-02	1.65E+01	2.85E+02	4.98E-01	1.99E-01	2.41E-04
Np-237	2.63E-14	1.22E-10	2.02E-11	6.51E-12	1.90E-12	1.65E-09	2.85E-08	4.98E-11	1.99E-11	2.41E-14
Pu-238	2.19E-09	1.02E-05	1.68E-06	5.42E-07	1.58E-07	1.37E-04	2.37E-03	4.14E-06	1.66E-06	2.00E-09
Pu-239	3.51E-10	1.63E-06	2.69E-07	8.69E-08	2.54E-08	2.20E-05	3.80E-04	6.64E-07	2.66E-07	3.22E-10
Pu-240	2.19E-10	1.02E-06	1.68E-07	5.42E-08	1.58E-08	1.37E-05	2.37E-04	4.14E-07	1.66E-07	2.00E-10
Pu-241	8.73E-08	4.07E-04	6.70E-05	2.16E-05	6.31E-06	5.48E-03	9.46E-02	1.65E-04	6.62E-05	8.00E-08
Sr-90	3.50E-07	1.63E-03	2.69E-04	8.67E-05	2.53E-05	2.20E-02	3.79E-01	6.63E-04	2.65E-04	3.21E-07
Tc-99	8.73E-09	4.07E-05	6.70E-06	2.16E-06	6.31E-07	5.48E-04	9.46E-03	1.65E-05	6.62E-06	8.00E-09
U-233	2.37E-12	1.10E-08	1.82E-09	5.87E-10	1.71E-10	1.49E-07	2.57E-06	4.48E-09	1.80E-09	2.17E-12
U-234	2.63E-12	1.22E-08	2.02E-09	6.51E-10	1.90E-10	1.65E-07	2.85E-06	4.98E-09	1.99E-09	2.41E-12
U-235	1.84E-16	8.58E-13	1.41E-13	4.56E-14	1.33E-14	1.16E-11	2.00E-10	3.49E-13	1.40E-13	1.69E-16
U-236	9.68E-15	4.51E-11	7.43E-12	2.40E-12	6.99E-13	6.07E-10	1.05E-08	1.83E-11	7.34E-12	8.87E-15
U-238	4.30E-14	2.00E-10	3.30E-11	1.06E-11	3.10E-12	2.70E-09	4.66E-08	8.13E-11	3.26E-11	3.94E-14

Table A-18 (continued). NRF-MOD-8H upper-bound estimate inventory summary (1966-1971).

	1966	1967	1968	1969	1970	1971	Total
Am-241	3.80E-06	9.02E-08	1.03E-06	1.07E-06	3.10E-10	2.41E-07	3.55E-03
C-14	8.68E-03	2.06E-04	2.35E-03	2.45E-03	7.07E-07	5.49E-04	8.10E+00
Cl-36	0.00E+00						
Co-60	1.08E+00	2.57E-02	2.93E-01	3.06E-01	8.81E-05	6.85E-02	1.01E+03
Cs-137	4.34E-04	1.03E-05	1.17E-04	1.23E-04	3.53E-08	2.75E-05	4.05E-01
H-3	0.00E+00						
I-129	4.35E-08	1.03E-09	1.18E-08	1.23E-08	3.54E-12	2.75E-09	4.06E-05
Nb-94	2.18E-04	5.16E-06	5.89E-05	6.15E-05	1.77E-08	1.38E-05	2.03E-01
Ni-59	3.26E-03	7.72E-05	8.81E-04	9.20E-04	2.65E-07	2.06E-04	3.04E+00
Ni-63	3.26E-01	7.72E-03	8.81E-02	9.20E-02	2.65E-05	2.06E-02	3.04E+02
Np-237	3.26E-11	7.72E-13	8.81E-12	9.20E-12	2.65E-15	2.06E-12	3.04E-08
Pu-238	2.71E-06	6.43E-08	7.34E-07	7.66E-07	2.21E-10	1.72E-07	2.53E-03
Pu-239	4.35E-07	1.03E-08	1.18E-07	1.23E-07	3.54E-11	2.75E-08	4.06E-04
Pu-240	2.71E-07	6.43E-09	7.34E-08	7.66E-08	2.21E-11	1.72E-08	2.53E-04
Pu-241	1.08E-04	2.57E-06	2.93E-05	3.06E-05	8.81E-09	6.85E-06	1.01E-01
Sr-90	4.34E-04	1.03E-05	1.17E-04	1.23E-04	3.53E-08	2.75E-05	4.05E-01
Tc-99	1.08E-05	2.57E-07	2.93E-06	3.06E-06	8.81E-10	6.85E-07	1.01E-02
U-233	2.94E-09	6.96E-11	7.94E-10	8.29E-10	2.39E-13	1.86E-10	2.74E-06
U-234	3.26E-09	7.72E-11	8.81E-10	9.20E-10	2.65E-13	2.06E-10	3.04E-06
U-235	2.28E-13	5.41E-15	6.18E-14	6.45E-14	1.86E-17	1.44E-14	2.13E-10
U-236	1.20E-11	2.85E-13	3.25E-12	3.39E-12	9.77E-16	7.60E-13	1.12E-08
U-238	5.33E-11	1.26E-12	1.44E-11	1.50E-11	4.34E-15	3.37E-12	4.97E-08

Table A-19. NRF-MOD-9H upper-bound estimate inventory summary (1954-1965).

	1954	1955	1957	1958	1959	1960	1961	1963	1964	1965
Am-241	7.12E-05	1.09E-04	9.10E-05	3.28E-05	1.98E-05	3.69E-06	3.65E-05	1.41E-05	1.03E-06	2.96E-03
C-14	1.31E-01	2.00E-01	1.67E-01	6.03E-02	3.63E-02	6.78E-03	6.71E-02	2.59E-02	1.89E-03	5.45E+00
Cl-36	0.00E+00									
Co-60	2.02E+01	3.09E+01	2.58E+01	9.32E+00	5.61E+00	1.05E+00	1.04E+01	3.99E+00	2.92E-01	8.41E+02
Cs-137	8.11E-03	1.24E-02	1.04E-02	3.74E-03	2.25E-03	4.20E-04	4.16E-03	1.60E-03	1.17E-04	3.38E-01
H-3	0.00E+00									
I-129	7.99E-07	1.22E-06	1.02E-06	3.69E-07	2.22E-07	4.14E-08	4.10E-07	1.58E-07	1.15E-08	3.33E-05
Nb-94	4.06E-03	6.21E-03	5.18E-03	1.87E-03	1.13E-03	2.10E-04	2.08E-03	8.02E-04	5.86E-05	1.69E-01
Ni-59	6.08E-02	9.31E-02	7.78E-02	2.81E-02	1.69E-02	3.15E-03	3.12E-02	1.20E-02	8.79E-04	2.53E+00
Ni-63	6.08E+00	9.31E+00	7.78E+00	2.81E+00	1.69E+00	3.15E-01	3.12E+00	1.20E+00	8.79E-02	2.53E+02
Np-237	6.08E-10	9.31E-10	7.78E-10	2.81E-10	1.69E-10	3.15E-11	3.12E-10	1.20E-10	8.79E-12	2.53E-08
Pu-238	5.09E-05	7.79E-05	6.50E-05	2.35E-05	1.41E-05	2.64E-06	2.61E-05	1.01E-05	7.35E-07	2.12E-03
Pu-239	8.11E-06	1.24E-05	1.04E-05	3.74E-06	2.25E-06	4.20E-07	4.16E-06	1.60E-06	1.17E-07	3.38E-04
Pu-240	5.09E-06	7.79E-06	6.50E-06	2.35E-06	1.41E-06	2.64E-07	2.61E-06	1.01E-06	7.35E-08	2.12E-04
Pu-241	2.03E-03	3.10E-03	2.59E-03	9.35E-04	5.63E-04	1.05E-04	1.04E-03	4.01E-04	2.93E-05	8.44E-02
Sr-90	8.11E-03	1.24E-02	1.04E-02	3.74E-03	2.25E-03	4.20E-04	4.16E-03	1.60E-03	1.17E-04	3.38E-01
Tc-99	2.03E-04	3.11E-04	2.60E-04	9.37E-05	5.65E-05	1.05E-05	1.04E-04	4.02E-05	2.94E-06	8.46E-03
U-233	5.49E-08	8.40E-08	7.01E-08	2.53E-08	1.52E-08	2.84E-09	2.82E-08	1.08E-08	7.93E-10	2.29E-06
U-234	6.12E-08	9.37E-08	7.83E-08	2.82E-08	1.70E-08	3.17E-09	3.14E-08	1.21E-08	8.85E-10	2.55E-06
U-235	4.26E-12	6.51E-12	5.44E-12	1.96E-12	1.18E-12	2.20E-13	2.18E-12	8.41E-13	6.15E-14	1.77E-10
U-236	2.24E-10	3.42E-10	2.86E-10	1.03E-10	6.21E-11	1.16E-11	1.15E-10	4.42E-11	3.23E-12	9.31E-09
U-238	9.94E-10	1.52E-09	1.27E-09	4.58E-10	2.76E-10	5.15E-11	5.10E-10	1.97E-10	1.44E-11	4.14E-08

Table A-19 (continued). NRF-MOD-9H upper-bound estimate inventory summary (1966-1971).

	1966	1967	1968	1969	1970	1971	Total
Am-241	8.27E-06	1.43E-02	3.41E-05	4.27E-05	1.43E-04	3.66E-05	1.79E-02
C-14	1.52E-02	2.63E+01	6.27E-02	7.84E-02	2.62E-01	6.72E-02	3.29E+01
Cl-36	0.00E+00						
Co-60	2.35E+00	4.06E+03	9.69E+00	1.21E+01	4.05E+01	1.04E+01	5.08E+03
Cs-137	9.42E-04	1.63E+00	3.89E-03	4.86E-03	1.63E-02	4.17E-03	2.04E+00
H-3	0.00E+00						
I-129	9.28E-08	1.60E-04	3.83E-07	4.79E-07	1.60E-06	4.11E-07	2.01E-04
Nb-94	4.71E-04	8.14E-01	1.94E-03	2.43E-03	8.13E-03	2.08E-03	1.02E+00
Ni-59	7.07E-03	1.22E+01	2.92E-02	3.65E-02	1.22E-01	3.12E-02	1.53E+01
Ni-63	7.07E-01	1.22E+03	2.92E+00	3.65E+00	1.22E+01	3.12E+00	1.53E+03
Np-237	7.07E-11	1.22E-07	2.92E-10	3.65E-10	1.22E-09	3.12E-10	1.53E-07
Pu-238	5.91E-06	1.02E-02	2.44E-05	3.05E-05	1.02E-04	2.61E-05	1.28E-02
Pu-239	9.42E-07	1.63E-03	3.89E-06	4.86E-06	1.63E-05	4.17E-06	2.04E-03
Pu-240	5.91E-07	1.02E-03	2.44E-06	3.05E-06	1.02E-05	2.61E-06	1.28E-03
Pu-241	2.36E-04	4.07E-01	9.72E-04	1.22E-03	4.06E-03	1.04E-03	5.10E-01
Sr-90	9.42E-04	1.63E+00	3.89E-03	4.86E-03	1.63E-02	4.17E-03	2.04E+00
Tc-99	2.36E-05	4.08E-02	9.74E-05	1.22E-04	4.07E-04	1.04E-04	5.11E-02
U-233	6.37E-09	1.10E-05	2.63E-08	3.29E-08	1.10E-07	2.82E-08	1.38E-05
U-234	7.11E-09	1.23E-05	2.94E-08	3.67E-08	1.23E-07	3.15E-08	1.54E-05
U-235	4.94E-13	8.54E-10	2.04E-12	2.55E-12	8.53E-12	2.19E-12	1.07E-09
U-236	2.60E-11	4.49E-08	1.07E-10	1.34E-10	4.48E-10	1.15E-10	5.62E-08
U-238	1.15E-10	2.00E-07	4.77E-10	5.96E-10	1.99E-09	5.11E-10	2.50E-07

Table A-20. NRF-MOD-10H upper-bound estimate inventory summary (1953-1962).

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Am-241	9.68E-07	7.95E-06	1.80E-06	2.18E-05	1.04E-04	6.49E-05	2.99E-04	7.61E-01	1.39E-02	2.01E-05
C-14	0.00E+00									
Cl-36	0.00E+00									
Co-60	2.76E-01	2.26E+00	5.11E-01	6.19E+00	2.96E+01	1.85E+01	8.51E+01	2.17E+05	3.96E+03	5.72E+00
Cs-137	1.10E-04	9.07E-04	2.05E-04	2.48E-03	1.19E-02	7.40E-03	3.41E-02	8.69E+01	1.59E+00	2.29E-03
H-3	0.00E+00									
I-129	1.11E-08	9.09E-08	2.05E-08	2.49E-07	1.19E-06	7.42E-07	3.42E-06	8.71E-03	1.59E-04	2.30E-07
Nb-94	5.54E-05	4.55E-04	1.03E-04	1.24E-03	5.95E-03	3.71E-03	1.71E-02	4.35E+01	7.97E-01	1.15E-03
Ni-59	8.29E-04	6.81E-03	1.54E-03	1.86E-02	8.91E-02	5.55E-02	2.56E-01	6.52E+02	1.19E+01	1.72E-02
Ni-63	4.39E-02	3.61E-01	8.15E-02	9.87E-01	4.72E+00	2.94E+00	1.36E+01	3.45E+04	6.32E+02	9.12E-01
Np-237	8.29E-12	6.81E-11	1.54E-11	1.86E-10	8.91E-10	5.55E-10	2.56E-09	6.52E-06	1.19E-07	1.72E-10
Pu-238	6.90E-07	5.67E-06	1.28E-06	1.55E-05	7.42E-05	4.62E-05	2.13E-04	5.43E-01	9.93E-03	1.43E-05
Pu-239	1.11E-07	9.09E-07	2.05E-07	2.49E-06	1.19E-05	7.42E-06	3.42E-05	8.71E-02	1.59E-03	2.30E-06
Pu-240	6.90E-08	5.67E-07	1.28E-07	1.55E-06	7.42E-06	4.62E-06	2.13E-05	5.43E-02	9.93E-04	1.43E-06
Pu-241	2.76E-05	2.26E-04	5.11E-05	6.19E-04	2.96E-03	1.85E-03	8.51E-03	2.17E+01	3.96E-01	5.72E-04
Sr-90	1.10E-04	9.07E-04	2.05E-04	2.48E-03	1.19E-02	7.40E-03	3.41E-02	8.69E+01	1.59E+00	2.29E-03
Tc-99	2.76E-06	2.26E-05	5.11E-06	6.19E-05	2.96E-04	1.85E-04	8.51E-04	2.17E+00	3.96E-02	5.72E-05
U-233	7.47E-10	6.14E-09	1.39E-09	1.68E-08	8.03E-08	5.01E-08	2.31E-07	5.88E-04	1.08E-05	1.55E-08
U-234	8.29E-10	6.81E-09	1.54E-09	1.86E-08	8.91E-08	5.55E-08	2.56E-07	6.52E-04	1.19E-05	1.72E-08
U-235	5.81E-14	4.77E-13	1.08E-13	1.31E-12	6.24E-12	3.89E-12	1.79E-11	4.57E-08	8.36E-10	1.21E-12
U-236	3.06E-12	2.51E-11	5.67E-12	6.87E-11	3.28E-10	2.05E-10	9.44E-10	2.40E-06	4.40E-08	6.34E-11
U-238	1.36E-11	1.11E-10	2.51E-11	3.05E-10	1.46E-09	9.08E-10	4.19E-09	1.07E-05	1.95E-07	2.81E-10

Table A-20. (continued). NRF-MOD-10H upper-bound estimate inventory summary (1963-1972).

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Am-241	2.17E-05	3.28E-04	3.47E-02	6.61E-03	1.59E-02	1.20E-04	8.23E-05	4.15E-05	5.65E-05	1.95E-05
C-14	0.00E+00									
Cl-36	0.00E+00									
Co-60	6.18E+00	9.33E+01	9.87E+03	1.88E+03	4.53E+03	3.42E+01	2.34E+01	1.18E+01	1.61E+01	5.55E+00
Cs-137	2.48E-03	3.74E-02	3.96E+00	7.54E-01	1.82E+00	1.37E-02	9.39E-03	4.74E-03	6.45E-03	2.22E-03
H-3	0.00E+00									
I-129	2.48E-07	3.75E-06	3.97E-04	7.55E-05	1.82E-04	1.37E-06	9.41E-07	4.75E-07	6.47E-07	2.23E-07
Nb-94	1.24E-03	1.88E-02	1.98E+00	3.78E-01	9.11E-01	6.87E-03	4.70E-03	2.38E-03	3.23E-03	1.12E-03
Ni-59	1.86E-02	2.81E-01	2.97E+01	5.66E+00	1.36E+01	1.03E-01	7.05E-02	3.56E-02	4.84E-02	1.67E-02
Ni-63	9.85E-01	1.49E+01	1.57E+03	3.00E+02	7.22E+02	5.45E+00	3.73E+00	1.88E+00	2.57E+00	8.85E-01
Np-237	1.86E-10	2.81E-09	2.97E-07	5.66E-08	1.36E-07	1.03E-09	7.05E-10	3.56E-10	4.84E-10	1.67E-10
Pu-238	1.55E-05	2.34E-04	2.47E-02	4.71E-03	1.13E-02	8.57E-05	5.86E-05	2.96E-05	4.03E-05	1.39E-05
Pu-239	2.48E-06	3.75E-05	3.97E-03	7.55E-04	1.82E-03	1.37E-05	9.41E-06	4.75E-06	6.47E-06	2.23E-06
Pu-240	1.55E-06	2.34E-05	2.47E-03	4.71E-04	1.13E-03	8.57E-06	5.86E-06	2.96E-06	4.03E-06	1.39E-06
Pu-241	6.18E-04	9.33E-03	9.87E-01	1.88E-01	4.53E-01	3.42E-03	2.34E-03	1.18E-03	1.61E-03	5.55E-04
Sr-90	2.48E-03	3.74E-02	3.96E+00	7.54E-01	1.82E+00	1.37E-02	9.39E-03	4.74E-03	6.45E-03	2.22E-03
Tc-99	6.18E-05	9.33E-04	9.87E-02	1.88E-02	4.53E-02	3.42E-04	2.34E-04	1.18E-04	1.61E-04	5.55E-05
U-233	1.68E-08	2.53E-07	2.68E-05	5.10E-06	1.23E-05	9.28E-08	6.35E-08	3.21E-08	4.36E-08	1.51E-08
U-234	1.86E-08	2.81E-07	2.97E-05	5.66E-06	1.36E-05	1.03E-07	7.05E-08	3.56E-08	4.84E-08	1.67E-08
U-235	1.30E-12	1.97E-11	2.08E-09	3.96E-10	9.55E-10	7.21E-12	4.94E-12	2.49E-12	3.39E-12	1.17E-12
U-236	6.85E-11	1.03E-09	1.09E-07	2.08E-08	5.02E-08	3.79E-10	2.60E-10	1.31E-10	1.78E-10	6.15E-11
U-238	3.04E-10	4.59E-09	4.86E-07	9.25E-08	2.23E-07	1.68E-09	1.15E-09	5.82E-10	7.92E-10	2.73E-10

Table A-20 (continued). NRF-MOD-10H upper-bound estimate inventory summary (1973-1981).

	1973	1974	1975	1976	1977	1978	1979	1980	1981
Am-241	3.15E-04	4.10E-04	4.97E-05	2.73E-05	2.88E-06	3.08E-06	1.20E-05	4.62E-05	1.18E-03
C-14	0.00E+00								
Cl-36	0.00E+00								
Co-60	8.95E+01	1.17E+02	1.41E+01	7.76E+00	8.21E-01	8.78E-01	3.40E+00	1.31E+01	3.36E+02
Cs-137	3.59E-02	4.68E-02	5.67E-03	3.11E-03	3.29E-04	3.52E-04	1.36E-03	5.27E-03	1.35E-01
H-3	0.00E+00								
I-129	3.60E-06	4.69E-06	5.69E-07	3.12E-07	3.30E-08	3.53E-08	1.37E-07	5.28E-07	1.35E-05
Nb-94	1.80E-02	2.35E-02	2.84E-03	1.56E-03	1.65E-04	1.76E-04	6.84E-04	2.64E-03	6.75E-02
Ni-59	2.69E-01	3.51E-01	4.26E-02	2.34E-02	2.47E-03	2.64E-03	1.02E-02	3.95E-02	1.01E+00
Ni-63	1.43E+01	1.86E+01	2.26E+00	1.24E+00	1.31E-01	1.40E-01	5.42E-01	2.09E+00	5.36E+01
Np-237	2.69E-09	3.51E-09	4.26E-10	2.34E-10	2.47E-11	2.64E-11	1.02E-10	3.95E-10	1.01E-08
Pu-238	2.24E-04	2.92E-04	3.54E-05	1.94E-05	2.06E-06	2.20E-06	8.52E-06	3.29E-05	8.41E-04
Pu-239	3.60E-05	4.69E-05	5.69E-06	3.12E-06	3.30E-07	3.53E-07	1.37E-06	5.28E-06	1.35E-04
Pu-240	2.24E-05	2.92E-05	3.54E-06	1.94E-06	2.06E-07	2.20E-07	8.52E-07	3.29E-06	8.41E-05
Pu-241	8.95E-03	1.17E-02	1.41E-03	7.76E-04	8.21E-05	8.78E-05	3.40E-04	1.31E-03	3.36E-02
Sr-90	3.59E-02	4.68E-02	5.67E-03	3.11E-03	3.29E-04	3.52E-04	1.36E-03	5.27E-03	1.35E-01
Tc-99	8.95E-04	1.17E-03	1.41E-04	7.76E-05	8.21E-06	8.78E-06	3.40E-05	1.31E-04	3.36E-03
U-233	2.43E-07	3.17E-07	3.84E-08	2.11E-08	2.23E-09	2.38E-09	9.23E-09	3.56E-08	9.11E-07
U-234	2.69E-07	3.51E-07	4.26E-08	2.34E-08	2.47E-09	2.64E-09	1.02E-08	3.95E-08	1.01E-06
U-235	1.89E-11	2.46E-11	2.98E-12	1.64E-12	1.73E-13	1.85E-13	7.17E-13	2.77E-12	7.08E-11
U-236	9.93E-10	1.29E-09	1.57E-10	8.61E-11	9.10E-12	9.73E-12	3.77E-11	1.46E-10	3.72E-09
U-238	4.41E-09	5.75E-09	6.96E-10	3.82E-10	4.04E-11	4.32E-11	1.67E-10	6.46E-10	1.65E-08

Table A-20 (continued). NRF-MOD-10H upper-bound estimate inventory summary (1982-1983).

	1982	1983	Total
Am-241	9.90E-06	1.48E-05	8.36E-01
C-14	0.00E+00	0.00E+00	0.00E+00
Cl-36	0.00E+00	0.00E+00	0.00E+00
Co-60	2.82E+00	4.20E+00	2.38E+05
Cs-137	1.13E-03	1.69E-03	9.54E+01
H-3	0.00E+00	0.00E+00	0.00E+00
I-129	1.13E-07	1.69E-07	9.56E-03
Nb-94	5.66E-04	8.45E-04	4.78E+01
Ni-59	8.47E-03	1.27E-02	7.16E+02
Ni-63	4.49E-01	6.70E-01	3.79E+04
Np-237	8.47E-11	1.27E-10	7.16E-06
Pu-238	7.05E-06	1.05E-05	5.96E-01
Pu-239	1.13E-06	1.69E-06	9.56E-02
Pu-240	7.05E-07	1.05E-06	5.96E-02
Pu-241	2.82E-04	4.20E-04	2.38E+01
Sr-90	1.13E-03	1.69E-03	9.54E+01
Tc-99	2.82E-05	4.20E-05	2.38E+00
U-233	7.64E-09	1.14E-08	6.45E-04
U-234	8.47E-09	1.27E-08	7.16E-04
U-235	5.94E-13	8.87E-13	5.01E-08
U-236	3.12E-11	4.66E-11	2.64E-06
U-238	1.39E-10	2.07E-10	1.17E-05

Appendix B

NRF Annual Inventory for RPDT Time Period 1984 through 1999: Best Estimates and Upper-Bound Estimates

Table B-1. NRF-MOD-6R best estimate inventory summary (1984-1989).

	1984	1985	1986	1987	1988	1989
Am-241	1.06E-02	4.59E-03	1.08E-03	9.49E-04	2.18E-04	4.02E-03
C-14	3.70E+00	1.61E+00	3.77E-01	3.32E-01	7.62E-02	1.41E+00
Cl-36	1.53E-02	6.65E-03	1.56E-03	1.38E-03	3.16E-04	5.83E-03
Co-60	4.61E+04	2.00E+04	4.70E+03	4.14E+03	9.49E+02	1.75E+04
Cs-137	6.87E-01	2.98E-01	7.01E-02	6.17E-02	1.42E-02	2.62E-01
H-3	1.06E+01	4.59E+00	1.08E+00	9.49E-01	2.18E-01	4.02E+00
I-129	3.70E-06	1.61E-06	3.77E-07	3.32E-07	7.62E-08	1.41E-06
Nb-94	4.91E-01	2.13E-01	5.00E-02	4.41E-02	1.01E-02	1.87E-01
Ni-59	1.13E+02	4.91E+01	1.15E+01	1.02E+01	2.33E+00	4.31E+01
Ni-63	1.28E+04	5.57E+03	1.31E+03	1.15E+03	2.64E+02	4.89E+03
Np-237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-238	6.72E-03	2.92E-03	6.85E-04	6.03E-04	1.38E-04	2.56E-03
Pu-239	1.59E-02	6.88E-03	1.62E-03	1.42E-03	3.27E-04	6.04E-03
Pu-240	9.82E-03	4.26E-03	1.00E-03	8.81E-04	2.02E-04	3.74E-03
Pu-241	8.31E-01	3.60E-01	8.47E-02	7.46E-02	1.71E-02	3.16E-01
Sr-90	3.63E-01	1.57E-01	3.70E-02	3.25E-02	7.46E-03	1.38E-01
Tc-99	1.96E-03	8.52E-04	2.00E-04	1.76E-04	4.04E-05	7.47E-04
U-233	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-234	1.06E-05	4.59E-06	1.08E-06	9.49E-07	2.18E-07	4.02E-06
U-235	3.02E-07	1.31E-07	3.08E-08	2.71E-08	6.22E-09	1.15E-07
U-236	9.82E-07	4.26E-07	1.00E-07	8.81E-08	2.02E-08	3.74E-07
U-238	1.13E-05	4.91E-06	1.15E-06	1.02E-06	2.33E-07	4.31E-06

Table B-1 (continued). NRF-MOD-6R best estimate inventory summary (1990-1996).

	1990	1991	1992	1993	1994	1996	Total
Am-241	2.25E-03	3.31E-03	1.61E-03	1.36E-03	9.79E-04	1.94E-08	3.09E-02
C-14	7.87E-01	1.16E+00	5.64E-01	4.75E-01	3.43E-01	6.81E-06	1.08E+01
Cl-36	3.26E-03	4.80E-03	2.34E-03	1.97E-03	1.42E-03	2.82E-08	4.49E-02
Co-60	9.79E+03	1.44E+04	7.02E+03	5.91E+03	4.27E+03	8.47E-02	1.35E+05
Cs-137	1.46E-01	2.15E-01	1.05E-01	8.82E-02	6.37E-02	1.26E-06	2.01E+00
H-3	2.25E+00	3.31E+00	1.61E+00	1.36E+00	9.79E-01	1.94E-05	3.09E+01
I-129	7.87E-07	1.16E-06	5.64E-07	4.75E-07	3.43E-07	6.81E-12	1.08E-05
Nb-94	1.04E-01	1.54E-01	7.48E-02	6.30E-02	4.55E-02	9.03E-07	1.44E+00
Ni-59	2.41E+01	3.55E+01	1.73E+01	1.45E+01	1.05E+01	2.08E-04	3.31E+02
Ni-63	2.73E+03	4.02E+03	1.96E+03	1.65E+03	1.19E+03	2.36E-02	3.76E+04
Np-237	0.00E+00						
Pu-238	1.43E-03	2.10E-03	1.02E-03	8.62E-04	6.23E-04	1.24E-08	1.97E-02
Pu-239	3.37E-03	4.97E-03	2.42E-03	2.04E-03	1.47E-03	2.92E-08	4.64E-02
Pu-240	2.09E-03	3.07E-03	1.50E-03	1.26E-03	9.09E-04	1.81E-08	2.87E-02
Pu-241	1.77E-01	2.60E-01	1.27E-01	1.07E-01	7.69E-02	1.53E-06	2.43E+00
Sr-90	7.71E-02	1.14E-01	5.52E-02	4.65E-02	3.36E-02	6.67E-07	1.06E+00
Tc-99	4.17E-04	6.15E-04	2.99E-04	2.52E-04	1.82E-04	3.61E-09	5.74E-03
U-233	0.00E+00						
U-234	2.25E-06	3.31E-06	1.61E-06	1.36E-06	9.79E-07	1.94E-11	3.09E-05
U-235	6.42E-08	9.46E-08	4.60E-08	3.88E-08	2.80E-08	5.56E-13	8.84E-07
U-236	2.09E-07	3.07E-07	1.50E-07	1.26E-07	9.09E-08	1.81E-12	2.87E-06
U-238	2.41E-06	3.55E-06	1.73E-06	1.45E-06	1.05E-06	2.08E-11	3.31E-05

Table B-2. NRF-MOD-10R best estimate inventory summary (1984-1989).

	1984	1985	1986	1987	1988	1989
Am-241	5.98E-03	2.18E-06	2.44E-06	8.37E-05	8.07E-07	1.43E-05
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	1.70E+03	6.20E-01	6.91E-01	2.37E+01	2.29E-01	4.04E+00
Cs-137	6.82E-01	2.49E-04	2.78E-04	9.54E-03	9.20E-05	1.63E-03
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	6.82E-05	2.49E-08	2.78E-08	9.54E-07	9.20E-09	1.63E-07
Nb-94	3.42E-01	1.25E-04	1.40E-04	4.79E-03	4.62E-05	8.17E-04
Ni-59	5.10E+00	1.86E-03	2.08E-03	7.14E-02	6.89E-04	1.22E-02
Ni-63	2.70E+02	9.88E-02	1.10E-01	3.78E+00	3.65E-02	6.45E-01
Np-237	5.10E-08	1.86E-11	2.08E-11	7.14E-10	6.89E-12	1.22E-10
Pu-238	4.26E-03	1.56E-06	1.74E-06	5.97E-05	5.76E-07	1.02E-05
Pu-239	6.82E-04	2.49E-07	2.78E-07	9.54E-06	9.20E-08	1.63E-06
Pu-240	4.26E-04	1.56E-07	1.74E-07	5.97E-06	5.76E-08	1.02E-06
Pu-241	1.69E-01	6.16E-05	6.87E-05	2.36E-03	2.28E-05	4.02E-04
Sr-90	6.82E-01	2.49E-04	2.78E-04	9.54E-03	9.20E-05	1.63E-03
Tc-99	1.70E-02	6.20E-06	6.91E-06	2.37E-04	2.29E-06	4.04E-05
U-233	4.60E-06	1.68E-09	1.88E-09	6.44E-08	6.21E-10	1.10E-08
U-234	5.10E-06	1.86E-09	2.08E-09	7.14E-08	6.89E-10	1.22E-08
U-235	3.59E-10	1.31E-13	1.46E-13	5.03E-12	4.85E-14	8.57E-13
U-236	1.88E-08	6.87E-12	7.67E-12	2.63E-10	2.54E-12	4.48E-11
U-238	8.36E-08	3.06E-11	3.41E-11	1.17E-09	1.13E-11	1.99E-10

Table B-2 (continued). NRF-MOD-10R best estimate inventory summary (1990-1997).

	1990	1991	1992	1993	1994	1995	1996	1997	Total
Am-241	1.21E-03	9.58E-05	8.41E-07	3.51E-06	1.34E-06	3.05E-05	1.28E-07	6.18E-08	7.42E-03
C-14	0.00E+00								
Cl-36	0.00E+00								
Co-60	3.42E+02	2.72E+01	2.39E-01	9.94E-01	3.81E-01	8.65E+00	3.62E-02	1.75E-02	2.10E+03
Cs-137	1.37E-01	1.09E-02	9.59E-05	4.00E-04	1.53E-04	3.48E-03	1.46E-05	7.05E-06	8.46E-01
H-3	0.00E+00								
I-129	1.37E-05	1.09E-06	9.59E-09	4.00E-08	1.53E-08	3.48E-07	1.46E-09	7.05E-10	8.46E-05
Nb-94	6.91E-02	5.49E-03	4.82E-05	2.01E-04	7.69E-05	1.75E-03	7.31E-06	3.54E-06	4.25E-01
Ni-59	1.03E+00	8.18E-02	7.18E-04	2.99E-03	1.15E-03	2.60E-02	1.09E-04	5.28E-05	6.33E+00
Ni-63	5.45E+01	4.34E+00	3.81E-02	1.59E-01	6.07E-02	1.38E+00	5.77E-03	2.80E-03	3.36E+02
Np-237	1.03E-08	8.18E-10	7.18E-12	2.99E-11	1.15E-11	2.60E-10	1.09E-12	5.28E-13	6.33E-08
Pu-238	8.60E-04	6.84E-05	6.00E-07	2.50E-06	9.58E-07	2.18E-05	9.10E-08	4.41E-08	5.29E-03
Pu-239	1.37E-04	1.09E-05	9.59E-08	4.00E-07	1.53E-07	3.48E-06	1.46E-08	7.05E-09	8.46E-04
Pu-240	8.60E-05	6.84E-06	6.00E-08	2.50E-07	9.58E-08	2.18E-06	9.10E-09	4.41E-09	5.29E-04
Pu-241	3.40E-02	2.70E-03	2.37E-05	9.89E-05	3.79E-05	8.60E-04	3.60E-06	1.74E-06	2.09E-01
Sr-90	1.37E-01	1.09E-02	9.59E-05	4.00E-04	1.53E-04	3.48E-03	1.46E-05	7.05E-06	8.46E-01
Tc-99	3.42E-03	2.72E-04	2.39E-06	9.94E-06	3.81E-06	8.65E-05	3.62E-07	1.75E-07	2.10E-02
U-233	9.28E-07	7.38E-08	6.47E-10	2.70E-09	1.03E-09	2.35E-08	9.82E-11	4.76E-11	5.71E-06
U-234	1.03E-06	8.18E-08	7.18E-10	2.99E-09	1.15E-09	2.60E-08	1.09E-10	5.28E-11	6.33E-06
U-235	7.25E-11	5.76E-12	5.06E-14	2.11E-13	8.07E-14	1.83E-12	7.67E-15	3.72E-15	4.46E-10
U-236	3.79E-09	3.02E-10	2.65E-12	1.10E-11	4.22E-12	9.60E-11	4.01E-13	1.95E-13	2.33E-08
U-238	1.69E-08	1.34E-09	1.18E-11	4.90E-11	1.88E-11	4.27E-10	1.79E-12	8.65E-13	1.04E-07

Table B-3. NRF-MOD-6S best estimate inventory summary (1998-1999).

	1998	1999	Total
Am-241	0.00E+00	0.00E+00	0.00E+00
C-14	2.99E-01	1.41E-01	4.39E-01
Cl-36	5.79E-03	2.44E-03	8.23E-03
Co-60	1.03E+03	4.33E+02	1.46E+03
Cs-137	0.00E+00	4.43E-02	4.43E-02
H-3	2.11E+00	5.71E-01	2.68E+00
I-129	1.98E-08	1.92E-08	3.89E-08
Nb-94	1.20E-01	1.24E-02	1.32E-01
Ni-59	1.63E+01	5.92E+00	2.22E+01
Ni-63	1.95E+03	7.19E+02	2.67E+03
Np-237	0.00E+00	0.00E+00	0.00E+00
Pu-238	0.00E+00	0.00E+00	0.00E+00
Pu-239	0.00E+00	0.00E+00	0.00E+00
Pu-240	0.00E+00	0.00E+00	0.00E+00
Pu-241	3.38E-02	1.97E-02	5.36E-02
Sr-90	2.40E-02	3.45E-02	5.85E-02
Tc-99	2.57E-04	2.40E-04	4.97E-04
U-233	0.00E+00	0.00E+00	0.00E+00
U-234	0.00E+00	0.00E+00	0.00E+00
U-235	0.00E+00	0.00E+00	0.00E+00
U-236	0.00E+00	0.00E+00	0.00E+00
U-238	0.00E+00	0.00E+00	0.00E+00

Table B-4. NRF-MOD-10S best estimate inventory summary (1998-1999).

	1998	1999	Total
Am-241	5.06E-06	8.45E-04	8.50E-04
C-14	6.20E-02	6.91E-02	1.31E-01
Cl-36	2.47E-05	3.42E-05	5.88E-05
Co-60	4.37E+00	6.05E+00	1.04E+01
Cs-137	9.66E-04	4.95E-02	5.04E-02
H-3	1.41E-02	9.65E-03	2.37E-02
I-129	2.71E-07	4.44E-07	7.15E-07
Nb-94	1.04E-02	1.34E-02	2.38E-02
Ni-59	9.95E-01	1.59E-01	1.15E+00
Ni-63	1.08E+02	5.30E+00	1.13E+02
Np-237	0.00E+00	0.00E+00	0.00E+00
Pu-238	2.58E-05	7.17E-04	7.43E-04
Pu-239	0.00E+00	1.13E-04	1.13E-04
Pu-240	0.00E+00	1.25E-04	1.25E-04
Pu-241	0.00E+00	1.49E-02	1.49E-02
Sr-90	1.72E-03	5.88E-02	6.05E-02
Tc-99	6.97E-05	1.64E-04	2.34E-04
U-233	0.00E+00	0.00E+00	0.00E+00
U-234	0.00E+00	0.00E+00	0.00E+00
U-235	0.00E+00	0.00E+00	0.00E+00
U-236	0.00E+00	0.00E+00	0.00E+00
U-238	0.00E+00	0.00E+00	0.00E+00

Table B-5. NRF-MOD-6R upper-bound estimate inventory summary (1984-1989).

	1984	1985	1986	1987	1988	1989
Am-241	2.11E-02	9.17E-03	2.16E-03	1.90E-03	4.35E-04	8.05E-03
C-14	7.40E+00	3.21E+00	7.55E-01	6.64E-01	1.52E-01	2.82E+00
Cl-36	3.06E-02	1.33E-02	3.12E-03	2.75E-03	6.30E-04	1.16E-02
Co-60	9.06E+04	3.93E+04	9.24E+03	8.14E+03	1.87E+03	3.45E+04
Cs-137	1.36E+00	5.90E-01	1.39E-01	1.22E-01	2.80E-02	5.17E-01
H-3	2.04E+01	8.84E+00	2.08E+00	1.83E+00	4.20E-01	7.76E+00
I-129	7.33E-06	3.18E-06	7.47E-07	6.58E-07	1.51E-07	2.79E-06
Nb-94	9.82E-01	4.26E-01	1.00E-01	8.81E-02	2.02E-02	3.74E-01
Ni-59	2.19E+02	9.50E+01	2.23E+01	1.97E+01	4.51E+00	8.33E+01
Ni-63	2.57E+04	1.11E+04	2.62E+03	2.31E+03	5.29E+02	9.77E+03
Np-237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-238	1.36E-02	5.90E-03	1.39E-03	1.22E-03	2.80E-04	5.17E-03
Pu-239	3.17E-02	1.38E-02	3.23E-03	2.85E-03	6.53E-04	1.21E-02
Pu-240	1.96E-02	8.52E-03	2.00E-03	1.76E-03	4.04E-04	7.47E-03
Pu-241	1.66E+00	7.21E-01	1.69E-01	1.49E-01	3.42E-02	6.32E-01
Sr-90	7.25E-01	3.14E-01	7.39E-02	6.51E-02	1.49E-02	2.76E-01
Tc-99	3.93E-03	1.70E-03	4.00E-04	3.53E-04	8.09E-05	1.49E-03
U-233	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-234	2.11E-05	9.17E-06	2.16E-06	1.90E-06	4.35E-07	8.05E-06
U-235	6.04E-07	2.62E-07	6.16E-08	5.42E-08	1.24E-08	2.30E-07
U-236	1.96E-06	8.52E-07	2.00E-07	1.76E-07	4.04E-08	7.47E-07
U-238	2.27E-05	9.83E-06	2.31E-06	2.03E-06	4.67E-07	8.62E-06

Table B-5 (continued). NRF-MOD-6R upper-bound estimate inventory summary (1990-1996).

	1990	1991	1992	1993	1994	1996	Total
Am-241	4.49E-03	6.62E-03	3.22E-03	2.71E-03	1.96E-03	3.89E-08	6.19E-02
C-14	1.57E+00	2.32E+00	1.13E+00	9.50E-01	6.86E-01	1.36E-05	2.17E+01
Cl-36	6.50E-03	9.58E-03	4.66E-03	3.92E-03	2.83E-03	5.63E-08	8.95E-02
Co-60	1.93E+04	2.84E+04	1.38E+04	1.16E+04	8.39E+03	1.67E-01	2.65E+05
Cs-137	2.89E-01	4.26E-01	2.07E-01	1.74E-01	1.26E-01	2.50E-06	3.98E+00
H-3	4.33E+00	6.39E+00	3.11E+00	2.62E+00	1.89E+00	3.75E-05	5.97E+01
I-129	1.56E-06	2.29E-06	1.12E-06	9.40E-07	6.79E-07	1.35E-11	2.14E-05
Nb-94	2.09E-01	3.07E-01	1.50E-01	1.26E-01	9.09E-02	1.81E-06	2.87E+00
Ni-59	4.66E+01	6.86E+01	3.34E+01	2.81E+01	2.03E+01	4.03E-04	6.41E+02
Ni-63	5.46E+03	8.04E+03	3.91E+03	3.29E+03	2.38E+03	4.72E-02	7.51E+04
Np-237	0.00E+00						
Pu-238	2.89E-03	4.26E-03	2.07E-03	1.74E-03	1.26E-03	2.50E-08	3.98E-02
Pu-239	6.74E-03	9.93E-03	4.83E-03	4.07E-03	2.94E-03	5.83E-08	9.28E-02
Pu-240	4.17E-03	6.15E-03	2.99E-03	2.52E-03	1.82E-03	3.61E-08	5.74E-02
Pu-241	3.53E-01	5.20E-01	2.53E-01	2.13E-01	1.54E-01	3.06E-06	4.86E+00
Sr-90	1.54E-01	2.27E-01	1.10E-01	9.30E-02	6.72E-02	1.33E-06	2.12E+00
Tc-99	8.35E-04	1.23E-03	5.98E-04	5.04E-04	3.64E-04	7.22E-09	1.15E-02
U-233	0.00E+00						
U-234	4.49E-06	6.62E-06	3.22E-06	2.71E-06	1.96E-06	3.89E-11	6.19E-05
U-235	1.28E-07	1.89E-07	9.21E-08	7.75E-08	5.60E-08	1.11E-12	1.77E-06
U-236	4.17E-07	6.15E-07	2.99E-07	2.52E-07	1.82E-07	3.61E-12	5.74E-06
U-238	4.82E-06	7.09E-06	3.45E-06	2.91E-06	2.10E-06	4.17E-11	6.63E-05

Table B-6. NRF-MOD-10R upper-bound estimate inventory summary (1984-1989).

	1984	1985	1986	1987	1988	1989
Am-241	1.19E-02	4.36E-06	4.86E-06	1.67E-04	1.61E-06	2.84E-05
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl-36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	3.39E+03	1.24E+00	1.38E+00	4.75E+01	4.58E-01	8.09E+00
Cs-137	1.36E+00	4.97E-04	5.54E-04	1.90E-02	1.84E-04	3.24E-03
H-3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	1.36E-04	4.98E-08	5.56E-08	1.91E-06	1.84E-08	3.25E-07
Nb-94	6.82E-01	2.49E-04	2.78E-04	9.54E-03	9.20E-05	1.63E-03
Ni-59	1.02E+01	3.73E-03	4.16E-03	1.43E-01	1.38E-03	2.43E-02
Ni-63	5.41E+02	1.98E-01	2.20E-01	7.57E+00	7.30E-02	1.29E+00
Np-237	1.02E-07	3.73E-11	4.16E-11	1.43E-09	1.38E-11	2.43E-10
Pu-238	8.50E-03	3.10E-06	3.46E-06	1.19E-04	1.15E-06	2.03E-05
Pu-239	1.36E-03	4.98E-07	5.56E-07	1.91E-05	1.84E-07	3.25E-06
Pu-240	8.50E-04	3.10E-07	3.46E-07	1.19E-05	1.15E-07	2.03E-06
Pu-241	3.39E-01	1.24E-04	1.38E-04	4.75E-03	4.58E-05	8.09E-04
Sr-90	1.36E+00	4.97E-04	5.54E-04	1.90E-02	1.84E-04	3.24E-03
Tc-99	3.39E-02	1.24E-05	1.38E-05	4.75E-04	4.58E-06	8.09E-05
U-233	9.20E-06	3.36E-09	3.75E-09	1.29E-07	1.24E-09	2.19E-08
U-234	1.02E-05	3.73E-09	4.16E-09	1.43E-07	1.38E-09	2.43E-08
U-235	7.15E-10	2.61E-13	2.92E-13	1.00E-11	9.65E-14	1.71E-12
U-236	3.76E-08	1.37E-11	1.53E-11	5.26E-10	5.08E-12	8.97E-11
U-238	1.67E-07	6.10E-11	6.80E-11	2.34E-09	2.25E-11	3.98E-10

Table B-6 (continued). NRF-MOD-10R upper-bound estimate inventory summary (1990-1997).

	1990	1991	1992	1993	1994	1995	1996	1997	Total
Am-241	2.40E-03	1.91E-04	1.68E-06	6.99E-06	2.68E-06	6.08E-05	2.55E-07	1.23E-07	1.48E-02
C-14	0.00E+00								
Cl-36	0.00E+00								
Co-60	6.84E+02	5.44E+01	4.77E-01	1.99E+00	7.62E-01	1.73E+01	7.24E-02	3.51E-02	4.21E+03
Cs-137	2.74E-01	2.18E-02	1.91E-04	7.98E-04	3.05E-04	6.94E-03	2.90E-05	1.41E-05	1.69E+00
H-3	0.00E+00								
I-129	2.75E-05	2.19E-06	1.92E-08	7.99E-08	3.06E-08	6.96E-07	2.91E-09	1.41E-09	1.69E-04
Nb-94	1.37E-01	1.09E-02	9.59E-05	4.00E-04	1.53E-04	3.48E-03	1.46E-05	7.05E-06	8.46E-01
Ni-59	2.06E+00	1.64E-01	1.44E-03	5.99E-03	2.29E-03	5.21E-02	2.18E-04	1.06E-04	1.27E+01
Ni-63	1.09E+02	8.67E+00	7.61E-02	3.17E-01	1.21E-01	2.76E+00	1.15E-02	5.59E-03	6.71E+02
Np-237	2.06E-08	1.64E-09	1.44E-11	5.99E-11	2.29E-11	5.21E-10	2.18E-12	1.06E-12	1.27E-07
Pu-238	1.71E-03	1.36E-04	1.20E-06	4.98E-06	1.91E-06	4.33E-05	1.81E-07	8.79E-08	1.05E-02
Pu-239	2.75E-04	2.19E-05	1.92E-07	7.99E-07	3.06E-07	6.96E-06	2.91E-08	1.41E-08	1.69E-03
Pu-240	1.71E-04	1.36E-05	1.20E-07	4.98E-07	1.91E-07	4.33E-06	1.81E-08	8.79E-09	1.05E-03
Pu-241	6.84E-02	5.44E-03	4.77E-05	1.99E-04	7.62E-05	1.73E-03	7.24E-06	3.51E-06	4.21E-01
Sr-90	2.74E-01	2.18E-02	1.91E-04	7.98E-04	3.05E-04	6.94E-03	2.90E-05	1.41E-05	1.69E+00
Tc-99	6.84E-03	5.44E-04	4.77E-06	1.99E-05	7.62E-06	1.73E-04	7.24E-07	3.51E-07	4.21E-02
U-233	1.86E-06	1.48E-07	1.29E-09	5.40E-09	2.07E-09	4.69E-08	1.96E-10	9.52E-11	1.14E-05
U-234	2.06E-06	1.64E-07	1.44E-09	5.99E-09	2.29E-09	5.21E-08	2.18E-10	1.06E-10	1.27E-05
U-235	1.44E-10	1.15E-11	1.01E-13	4.19E-13	1.61E-13	3.65E-12	1.53E-14	7.40E-15	8.88E-10
U-236	7.58E-09	6.03E-10	5.29E-12	2.21E-11	8.45E-12	1.92E-10	8.03E-13	3.89E-13	4.67E-08
U-238	3.37E-08	2.68E-09	2.35E-11	9.79E-11	3.75E-11	8.52E-10	3.56E-12	1.73E-12	2.07E-07

Table B-7. NRF-MOD-6S upper-bound estimate inventory summary (1998-1999).

	1998	1999	Total
Am-241	0.00E+00	0.00E+00	0.00E+00
C-14	7.31E-01	3.44E-01	1.08E+00
Cl-36	5.79E-03	2.44E-03	8.23E-03
Co-60	2.44E+03	1.03E+03	3.47E+03
Cs-137	0.00E+00	9.74E-02	9.74E-02
H-3	4.97E+00	1.34E+00	6.32E+00
I-129	7.19E-08	6.97E-08	1.42E-07
Nb-94	1.20E-01	1.24E-02	1.32E-01
Ni-59	1.63E+01	5.92E+00	2.22E+01
Ni-63	4.57E+03	1.68E+03	6.25E+03
Np-237	0.00E+00	0.00E+00	0.00E+00
Pu-238	0.00E+00	0.00E+00	0.00E+00
Pu-239	0.00E+00	0.00E+00	0.00E+00
Pu-240	0.00E+00	0.00E+00	0.00E+00
Pu-241	3.38E-02	1.97E-02	5.36E-02
Sr-90	5.77E-02	8.28E-02	1.41E-01
Tc-99	5.87E-04	5.48E-04	1.13E-03
U-233	0.00E+00	0.00E+00	0.00E+00
U-234	0.00E+00	0.00E+00	0.00E+00
U-235	0.00E+00	0.00E+00	0.00E+00
U-236	0.00E+00	0.00E+00	0.00E+00
U-238	0.00E+00	0.00E+00	0.00E+00

Table B-8. NRF-MOD-10S upper-bound estimate inventory summary (1998-1999).

	1998	1999	Total
Am-241	5.06E-06	8.45E-04	8.50E-04
C-14	1.52E-01	1.69E-01	3.21E-01
Cl-36	2.47E-05	3.42E-05	5.88E-05
Co-60	1.04E+01	1.44E+01	2.48E+01
Cs-137	2.13E-03	1.09E-01	1.11E-01
H-3	3.31E-02	2.27E-02	5.59E-02
I-129	9.87E-07	1.61E-06	2.60E-06
Nb-94	1.04E-02	1.34E-02	2.38E-02
Ni-59	9.95E-01	1.59E-01	1.15E+00
Ni-63	2.53E+02	1.24E+01	2.65E+02
Np-237	0.00E+00	0.00E+00	0.00E+00
Pu-238	2.58E-05	7.17E-04	7.43E-04
Pu-239	0.00E+00	1.13E-04	1.13E-04
Pu-240	0.00E+00	1.25E-04	1.25E-04
Pu-241	0.00E+00	1.49E-02	1.49E-02
Sr-90	4.13E-03	1.41E-01	1.45E-01
Tc-99	1.59E-04	3.76E-04	5.35E-04
U-233	0.00E+00	0.00E+00	0.00E+00
U-234	0.00E+00	0.00E+00	0.00E+00
U-235	0.00E+00	0.00E+00	0.00E+00
U-236	0.00E+00	0.00E+00	0.00E+00
U-238	0.00E+00	0.00E+00	0.00E+00